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COUNTY OF SAN MATEO

TECHNOLOGY ARCHITECTURE

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INTRODUCTORY DISCUSSIONS

Overview

The purpose of the Technology Architecture project is to provide County of San Mateo [1]agencies with guidelines for selecting the technology components of information systems. The objective of such guidelines is to facilitate:

- Improvement in the openness of architectures thereby facilitating interoperability of business applications.

- Reduction in the number of disparate or uncommon technologies thereby improving the maintenance of business applications.

- Exploitation of the latest technologies in an informed and thoughtful manner thereby optimizing both the life of applications and investments in technologies.

This document is intended to be used as a reference for those who make technology decisions and, therefore, is technical in nature and assumes some technical understanding. The guidelines are not intended to challenge current configurations. Rather, they are aimed at meeting the previously stated objectives through future purchases and upgrades. In some cases, guidelines for the selection of specific products are offered when it has been determined that such guidelines have distinct advantages for the County. In all cases, the guidelines are offered in light of: (1) current technologies throughout the County, (2) County business directions and trends, and (3) market trends for computing technologies.

Given the dynamic nature of both technologies and County business directions, the CSM Technology Architecture is also dynamic. It is intended to be updated as needed to address the County's changing needs and new technologies as they offer advantages to the County. For this reason, a mechanism will be put in place to maintain the technology architecture.

Further, because some technologies covered by the guidelines are new to the market or County, recommendations for pilot studies are made. These pilots should be of sufficient scope to allow the various agencies to evaluate the component technologies.

The Technology Architecture project is actually one of four projects which will ultimately contribute to the overall County of San Mateo Technological Architecture. The four projects are:

> Technology Architecture
>
> Non-Mainframe System Management Guidelines
>
> Desktop Solutions
>
> Enterprise Network Architecture

The Technology Architecture project differs from the other projects in two ways: (1) it is strategic in nature in that it focuses on future decisions, and (2) it crosses-over and

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[1] For the purposes of this document, 'agency' is used as a generic term to refer to County entities commonly referred to as 'agency' or 'department'.

integrates with the other projects. Additionally, it comprises two phases: (1) Technology Architecture definition, and (2) Transition Plan creation. The goal of the second phase is to develop a high level plan for transitioning toward the newly defined technology architecture.

Scope of Guidelines

The guidelines are organized into three major groups of architectural components: (1) Operating System Guidelines, (2) Hardware Platform Guidelines, and (3) System Services and Functions Guidelines.

> Operating System Guidelines: Guidelines for operating system selection will be presented in terms of the different types of platforms that may be employed: Desktops, Network Servers, Application Servers.

> Hardware Platforms Guidelines: Guidelines for hardware platform selection will be presented in terms of the different types of platforms that may be employed: Desktops, Network Servers, Application Servers.

> System Services/Functions Guidelines: Guidelines will be presented for the following categories of system services and functions:

>> Applications Development Tools and Languages

>> Database Management

>> Decision Support Tools

>> Document/imaging management

>> E-mail/messaging

>> Middleware

>> On-Line Information Sharing

>> Peripheral Sharing

>> Remote Access

>> System Management

>> Workflow management

For each of the above architecture components, the following areas are covered: (1) a description of the given component, (2) discussion of the problems addressed by guidelines for selection, (3) state of the market, (4) considerations and criteria for product selection, and (5) discussion of specific product guidelines (as appropriate).

Approach

In order to establish a reasonable and useful set of guidelines, it is important to understand both the technologies in place throughout the County and the various agencies' business directions. With this in mind, the first step of the project was to update the application and technology inventory initially established in 1992 (Deloitte and Touche report); and at the same time, investigate where the various agencies are headed with technologies given their business directions. This was accomplished by querying each agency via written survey. The intent of this effort was not as much to build a detailed and complete inventory as it was to have a baseline for cross-checking with the guidelines. For this reason, and time constraints, the focus was on identifying key business applications and the associated platforms. The baseline and business directions were used as considerations when evaluating options. For example, the extent to which alternative operating systems are used for business critical applications, was taken into account when determining guidelines for application servers. Additionally, the updated inventory will be extremely useful, in conjunction with the new technology architecture, for communicating the current environment to third party organizations (technology vendors or consulting companies, for example).

In parallel with the County survey, a first draft of guidelines was developed based on working knowledge and research of the technology market. Given the draft guidelines and available survey results, a five day workshop was conducted to refine the guidelines to meet the county's objectives. For the architecture project, a team of County employees was established. These members attended the workshops and participated in the review of the architecture document. They were selected for their experience in County of San Mateo business uses of technology, knowledge of business directions and issues, and their understanding of specific technology areas. Together in the workshop and during the review process, this complimentary expertise was used to define the architecture for the County.

The team included the following people:

Kaye Crawford	ISD
Bill Grimes	ISD
Gloria Kanu	ISD
Pat Kulm	ISD
Ed Lusnich	ISD
Tito Olazabal	Public Works
Tom Platner	Health Services
Paul Strobeck	District Attorney
Jay Thompson	ISD
Hugh Vincent	ISD
Greg Wertis	ISD

Kathleen Welch of the Controller's Office also provided input on selected topics. In addition to the County Technology Architecture Team, a consulting firm, DBSS Inc., was

contracted to aid in developing the draft architecture, conduct the workshop and contribute technology and market expertise in the workshop.

The following factors were considered for the development of the technology architecture guidelines:

Scope of Application Usage. For example, is or will a given application or set of applications be used County wide, agency wide, or by individuals within the agency. Will the data be shared among users or will each user have his/her own set.

Role and Priority of Applications. Here the issue is the role and relative importance of the given application(s). For example is the application core or mission critical, for decision support or for office automation. Given its role, how key is the application to the functioning of the agency. Does the application see frequent or infrequent use. The objectives are both to: (1) identify those applications key to the agencies' business functions which may or should influence technology decisions, (2) determine appropriate architecture given the role of high impact applications.

Current State of Technologies. What technologies are currently in place? What are their relative priorities? The objective is to determine if and how current technologies should impact the introduction of new technology. For example, it may be appropriate to consider the interoperability of a core application and any new technologies to be introduced.

Business Directions of Agency. What are key opportunities for the way in which the agency processes and uses data? Likewise where is the agency headed in terms of its use of data and processing requirements? The objective is to identify potential impacts on the technologies to be in place in order to meet the agency's objectives.

Technical Factors. For example, how will the use of current technologies be impacted by the introduction of new technology?

Market Factors. The current market place remains very dynamic. Therefore, in addition to understanding the state of the market, it is crucial to both keep sight of where it is headed and identify those solutions which offer longevity. That way, any technology investments will evolve with other technologies in the market place with minimal impact.

Summary of Guidelines

The resulting guidelines are a mixture of specific product recommendations or criteria for making product selections. Specific product recommendations are made where it has been determined to be a distinct advantage to the County. Such recommendations are to be re-evaluated on a regular basis, either based on time or on market milestones such as new technologies, product updates, or significant market share changes. They are intended to provide decision makers a tool for evaluating new purchase and upgrade options. It is recommended that in cases where specific products are specified, selections of alternative products be based on specific application requirements.

It is critical to note that these guidelines are not intended to be a catalyst for sudden or rapid migration to the specified technology components. Rather, they are intended to provide guidance when agencies are considering new purchases and upgrades for appropriate business reasons.

The detailed guidelines follow this section. The following summarizes the guidelines for each of the technology areas:

Operating System Guidelines

Desktop Operating Systems

- Windows 3.1 or Windows for Workgroups

Network Operating Systems

- Novell Netware

Application Server Operating Systems

- Netware or UNIX

Hardware Platform Guidelines

Desktop Hardware

- Operating system vendor certified platforms, preferably Intel Pentium workstations to maximize the investment

Network Server Hardware

- Netware compatible Intel Pentium servers

Applications Server Hardware

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

System Services/Functions Guidelines

Application Development Tools and Languages

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

Database Management

- ORACLE7, Sybase SQL Server System 10, Informix or Gupta SQLBase, depending on application.

Decision Support Tools

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

Document/Imaging Management

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

E-Mail and Messaging

- Novell GroupWise or Microsoft Mail and Schedule+.

Middleware

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

On-Line Information Sharing

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

Peripheral Sharing

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

Remote Access

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

System Management

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

Workflow Management

- Specific products are not specified, refer to detailed guidelines for selection criteria and considerations.

Next Steps

This architecture document is "version 1.0" of a living document that will develop with and as the County and technology change. Completion of this version is only the first step toward the County achieving its objectives in undertaking this effort.

The Transition Plan phase of this project will create a high level plan for moving toward this architecture. Besides the Transition Plan, follow-on steps include:

Approval: The County's Information Technology Steering Committee will be asked to approve the results of this project and the other associated architecture projects.

Adoption: The County's objectives can be met only if the information is useful to and used by decision makers in County agencies. This architecture will be distributed to and reviewed with County technologists to ensure the information is available to those who can use it best.

Integration: Beyond coordinating this document with other architecture efforts, this project will examine how best to integrate with existing County processes for planning, acquiring and managing technology. The activities that make this a living document will be vital to this integration.

OPERATING SYSTEM GUIDELINES

Desktop Operating Systems

Description

In an integrated architecture consisting of desktops, network servers, application servers, and peripherals on a network, desktops may serve one or more of the following functions:

- Application platform. The workstation houses both the application and data. This is typical for single user software.

- Host Terminal. The workstation executes software which allows it to emulate a terminal communicating with a mainframe or minicomputer host system.

- Database Server Client. The workstation sends requests to and receives data from a database server. In this scenario the server does most of the data manipulation while the client handles the interface to the data and application functions.

- Network Server Client. The workstation uses files stored on a network server's hard disk, while all software executes on the client. This architecture allows common files, documents and programs to be shared by multiple users.

The desktop operating system is software which manages the operation of the computer's activities. It controls allocation and usage of the various hardware resources including memory, disk space, peripheral devices, etc.

Issues

Guidelines for the selection of desktop operating systems should address the following issues and criteria:

- Providing optimal functionality while minimizing the cost of replacing or upgrading hardware.

- Minimizing risk of obsolescence by investing in special or 'non-standard' desktop hardware.

- Determining which operating systems provide the greatest availability of desktop software.

- Determining which operating system choices best support network administration.

- Ensuring the availability of experienced developers and minimizing retraining or hiring costs.

- Minimizing cost and complexity of installation and maintenance.

- Maximizing the user's ability to run applications and access data on diverse hardware platforms and operating systems.

- Maximizing the ability to use existing applications and minimizing modification or re-engineering costs.

State of the Market

The current desktop OS market is one of increasing domination by Microsoft with Windows 3.11 (and the underlying DOS operation system). The major application vendors have all given top priority to Windows development. Because the rapid sales of Windows applications is driving new software development, the importance of supporting Windows based applications is growing dramatically. Microsoft's strategy of luring all development projects into using the Windows related applications framework (known as MFC (Microsoft Foundation Classes)), is bringing more and more development projects into the Windows fold.

Windows 3.11 is Intel CPU specific, so this further strengthens the Microsoft/Intel combination of software and hardware as the dominant force in the industry. Microsoft introduced Windows NT this past year to bring out an industrial strength operating system. This OS is not necessarily suitable for the average desktop, having large disk and memory requirements. The benefit of NT is that it is hardware independent (to a degree), allowing it to be run on more than one hardware (CPU) platform. NT also runs current Windows applications and looks and feels virtually identical to Windows 3.11. There are two version of Windows NT: NT Workstation and NT Server.

Windows For Workgroups has now been specified, by Microsoft, to be the desktop OS of choice. The three primary reasons they give for this are:

- Higher performance
- Workgroup functionality
- It is closer in functionality to Windows 95 than is regular Windows.

Windows for Workgroups also includes Microsoft Mail and Schedule+ as components of the operating system. This ties in well with the mail guideline (Microsoft Mail) specified later in this architecture.

A new version of Windows, Windows 95, is due early in 1995. This desktop OS is meant to build upon the momentum of Windows 3.11 with improvements borrowed from other competing desktop OSs. Windows 95 runs as a complete operating system, without requiring MS-DOS. This product is shaping up to be the logical upgrade path for Windows for Workgroups users.

IBM's OS/2 is another option for Intel PC desktops. OS/2 has been around for a number of years but has yet to accumulate enough critical mass to challenge Microsoft. It is generally regarded as a stable OS with an intriguing GUI. However, there are relatively few OS/2 specific applications available. OS/2 will run Windows applications, which is a big advantage for the moment, but the licensing agreement that IBM has had with Microsoft for Windows support code runs out as of this year and so IBM does not have this available to them for *future* Windows application support.

IBM has just released the latest version of OS/2, but the orientation for this version is initially for the home or stand-alone user. The needed utilities to tie OS/2 into the LAN are to be released in the next quarter. Also, IBM has struggled to complete porting of

OS/2 code and has been slipping their delivery dates for a version of OS/2 for their new PowerPC hardware (while the port of Microsoft's NT to the PowerPC finished quickly).

The Macintosh OS is important with regards to market share, but is not a driving force in the marketplace. Currently the Mac operating system is tightly integrated with the Apple hardware (with no clone vendors currently on the market). This tight coupling of OS to hardware creates an effective package that at one time was years ahead of the industry. Several versions of leading applications run on the Macintosh, but the support for a wide variety of applications is not close to that of Windows applications. At this point in time, the Macintosh is not a very serious contender unless there is already a large presence of Macintoshes in an organization.

There is a small push for using UNIX as a desktop operating system, with Motif on X (the most common UNIX GUI) as the desktop interface. While this can be appealing to engineering or scientific workgroups, the lack of mainstream commercial applications and the high resource requirements relegate UNIX to be an niche player in the desktop OS market.

Considerations for the Selection of Desktop Operating Systems

Given the state of the market and technologies for Desktop Operating Systems, the following criteria should be considered when making product selections:

- The desktop OS should optimize the reuse of existing desktop hardware. The OS should run on current desktop machines and also on upcoming desktop machines. The OS should minimize the requirement for major hardware additions or completely new machines. However, there should not be a requirement for full retroactive hardware support, only a sensible level of support for existing desktop hardware. An example would be a requirement that a desktop OS support Intel based machines from the current Pentium class machines retroactively back through XT (1984 era) class machines. Though an extreme case, this requirement would cause a complete halt to any acceptance of a modern OS and in turn cause a dearth of software availability and a halt to any new hardware acceptance.

- The desktop OS should not have extensive hardware requirements. The OS should be able to run in minimal configurations if needed so that all machines could be standardized on the OS, not just the machines that meet the hardware requirements of the OS. Minor hardware upgrades for below-minimal configurations could be acceptable, but there should not be a requirement for huge amounts of memory or disk-space or other hardware components. A commonsense approach should be taken to hardware requirements in light of the current hardware requirements for desktop OS. A few years ago a desktop machine with 1 megabyte of RAM would have been quite sufficient. For current OS and current *applications* this is a below-minimum configuration.

- The desktop OS should not lead to investment in special or 'non-standard' desktop hardware. The OS should be able to support common 'off-the-shelf' hardware and not require the purchase of 'non-standard' hardware that will eventually end up being an expensive technological 'dead-end'. An example would be the Wang dedicated word processing computers. Though functional in their time, non-standard hardware forced the early retirement of these systems while more standardized and less specialized systems remained viable for many years.

- The desktop OS should be easy to use. The OS should not require arcane commands to be learned or mimicked in order to run applications. The difference is most evident in OS that support GUI (Graphical User Interface) and those that do not. Command line based interfaces are on the wane with the acceptance of GUI based OS. Some command line based OS support shells that give the user a GUI (such as MS Windows on DOS, or Motif on UNIX). The important thing is that there is some intuitive method for accessing the applications, files, and data that the user needs with a minimum of training and support.

- The desktop OS should be viable in the market and suggest growth and stability over the long run. It is very important that resources not be wasted on an OS that will not be around in a few years.

- The desktop OS should optimize the availability of desktop software to meet organization business needs. This means that the OS should not limit the use of software that is important to productivity for the business. A user should not be forced to learn difficult non-intuitive applications just because the OS does not support the commonly available software. One should not be forced to learn a series of cryptic and difficult commands and programs instead of being able to use a standard word processor such as WordPerfect or Word for Windows.

- The desktop OS should support network administration through inclusion of administration features or availability of third party administration software. An OS should support network administration efforts, not hinder them.

- The desktop OS should maximize the availability of developers experienced with programming in that environment. If there is not an established developer community for the OS, knowledgeable and talented personnel will be difficult to find or be very expensive. Development projects could be put on hold while a search is undertaken to find candidates with specialized skills. It is also extremely advantageous if in-house developers can easily migrate their skills to a new OS (such as the upcoming move from Windows For Workgroups to Windows 95).

- The desktop OS should be easy to install and facilitate the installation and maintenance of OS adjuncts such as drivers, software applications, and peripheral hardware. If the OS is too difficult to support and maintain, the demands on the support staff could be unmanageable.

- The desktop OS should optimize the user's ability to run applications and access data on diverse hardware platforms and operating systems through native or add-on connectivity capabilities. A desktop OS should not be an island, but rather the enabling tool for the user to take full advantage of resources such as applications and data.

- The desktop OS should optimize the ability to use existing applications. This backwards compatibility of applications is important for an OS in that there is no loss of productivity while replacement applications are developed or purchased (with the inherent training and learning curve costs).

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- For new purchases, users should purchase Microsoft Windows for Workgroups v3.11.

- For upgrades:
  - If the current version of Windows is less than 3.1 or 3.11, upgrade to WfW v3.11 or Windows 3.1.
  - If the current version of Windows is 3.1 or 3.11, there is no compelling reason to upgrade at this time.

- When access to a host is required, users should first consider use of terminal emulators and X-emulators running on Windows before going with terminals or UNIX workstations.

- These guidelines should be revisited when Windows 95 is available.

Network Server Operating System

Description

A network server manages the activities on a network. It controls access to some combination of the network, traffic across the network, and often the access and use of resources on the network.

Issues

In addition to those associated with desktop operating systems, guidelines for the selection of network operating systems should address the following issues and criteria:

- Determining which network server operating systems can best accommodate increasing capacity requirements.

- Maximizing interoperability (i.e. through range communication protocol support) of applications and networking activities with those on other networks, operating systems and hardware platforms.

- Determining which network operating system has the richest set of functionality.

- Determining which network operating systems offer the most robust administration features for multiple servers.

- Maximizing the availability of vendor supplied or third party add-ons.

- Maximizing support of existing network hardware, peripherals, desktop operating systems.

- Determining which network operating systems offer the most robust administration features for security.

- Maximizing the availability of vendor supplied or third party hardware, peripherals, and network based software.

- Minimizing time and cost of redundant administrative tasks.

State of the Market

The network server OS market is dominated by Novell with its NetWare product line. Netware currently holds approximately 65% of the market. The other competitors include Microsoft's Windows NT Server (NTS), Banyan Vines, IBM's LAN Server, and various UNIX OSs.

Novell has been a strong leader in this category, but is starting to show signs of weakness with a slow adoption of its latest NetWare release, version 4. Netware has excellent third party support, and version 3.12 is very reliable. Novell offered global naming services (GNS) in version 3.12 but was slow to offer enterprise level directory services (now included in version 4). The Novell NOS is a true OS and supports networked applications at the server level (called NLMs - NetWare Loadable Modules). The ability of NetWare to tie together microcomputers, minicomputers, mainframes, workstations, multiple protocols, topologies, various communications links, and virtually any application is the big selling point. Less advantageous are the cost, the need for well trained support, difficulty in setup, and the limitations on concurrent users per server (250 per server for version 3.12). Fortunately, training is available and qualified personnel can be found relatively easily.

Microsoft's NTS is a new/old entrant into the NOS market. Microsoft Windows NT (new) is the foundation upon which an updated version of LAN Manager (old) has been built. The combination works well, with an extremely easy set of administration features that requires little training. NTS is very easy to install and administer, and performs well for a new product. It does lack some of the broad reaching support of NetWare due to its youth, but bearing the Microsoft name bodes well for third party support and the viability of the product in the marketplace. While it could be viewed as an immature NOS, its roots in LAN Manager clears up some of the growing pains associated with software. NTS is currently best suited for organizations using only Windows due to the lack of

available support, but this is rapidly changing and NTS can be viewed as a viable competitor to NetWare. NTS is now in its second release (v3.5).

Banyan VINES is lauded for its excellent WAN (Wide Area Network) support, but lacks some of the amenities and range of services found in NetWare or NTS. It is based upon an old version of UNIX. IBM's LAN Server is an OS/2 based server that is generally found in IBM-only organizations, and is technically inferior to the other products discussed..

UNIX itself can be used as a NOS, offering the expected services through third party support for protocols (such as NetManage TCP/IP suite of tools for DOS/Windows clients to access UNIX systems) and network file sharing (NFS). Due to the differing flavors and variants of UNIX and the lack of cohesive cross platform client support, this option can be problematic in an organization not proficient in UNIX. Implemented by knowledgeable staff, this can be a very cost effective alternative to using a dedicated NOS. A side bonus is that Windows NT is moving towards greater interoperability with UNIX, so a mix and match of NTS and UNIX could be a viable option in organizations with an existing strong UNIX presence.

Considerations for the Selection of Network Operating Systems

Given the state of the market and technologies for Network Operating Systems, the following criteria should be considered when making product selections:

- A Network Operating System should be scaleable in capacity. Virtually all of the NOSs are scaleable to some degree, but the abilities of NT and UNIX to scale exceed the rest.

- A Network Operating System should offer simple, straightforward administration facilities. This is often the weakest point for most NOSs, but NTS offers the best in administrative features. NetWare, though highly configurable, can be difficult to administer.

- A Network Operating System should support current and future hardware, including peripherals and network hardware. This is true for both the server hardware and the client hardware. The NOS should support a wide array of equipment and not force the abandonment of hardware due to lack of support by the NOS. An example would be support for Macintoshes, which are often found in role specific workgroups such as graphics or marketing. Novell NetWare excels in this role.

- A Network Operating System should support security at user, domain, and file levels. This is particularly important for larger organizations that need to limit file, application, and data access at different levels of granularity. All of the NOS provide security to some degree, but one should choose a NOS with full featured security administration (such as NetWare or NTS) over UNIX with its complexity of setting up, administrating, and maintaining security features.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- For new purchases:

  - Small workgroups   -   Microsoft Windows for Workgroups

  - LANs/WANs   -   Novell NetWare v4.1

  Novell Netware is recommended in light of its large installed base within the County; its strong position in the market place; its support of TCP/IP which is key to WAN connectivity. Given the considerations stated above, there is no compelling reason to select NTS or UNIX as the guideline.

- For upgrades:

  - For those users currently using NetWare v3.11 or 3.12, there is no compelling reason to upgrade at this time.

  - In cases where network size and the number of servers is an issue, upgrade to Netware V4.1. NetWare V4.1 is not recommended for all cases due to the complexity of setup to take advantage of its new features. Also, with the exception of its ability to scale, there is no compelling reason to upgrade at this time.

These guidelines should be revisited upon the availability of Windows NT Server 95 (Cairo), with major new releases of Novell Netware, and with major changes in the County's networking plan.

Application Server Operating Systems

Description

Application servers run specialized applications on the network for the purposes of serving multiple users and centralizing certain processes and data. The application server may be a mainframe, minicomputer, or microcomputer. Relational Database Management Systems (RDBMS) run on application servers in client/server architectures.

Issues

In addition to those associated with desktop operating and network operating systems, guidelines for the selection of application server operating systems should address the following issues and criteria:

- Striking the balance between minimizing cost and providing processing power and functionality.

- Reducing or eliminating the organization's risk to system failure and data corruption.

- Supporting concurrent access to data and applications to multiple users.

- Supporting access to data regardless of location of the user.

- Determining which application server operating system best supports both the sharing or integration of data and the distribution of processing.

- Maximizing hardware independence.

- Maximizing capacity for handling concurrent processes.

State of the Market

Application servers are generally thought of as the OS/hardware base for applications such as a relational database management systems (RDBMS) or Lotus Notes. The OS for an application server is largely dependent on the application it is meant to support. Thus, a server OS that supports an application such as Lotus Notes (OS/2) quite well may be less suitable as a server OS for an RDBMS. It is also important that the OS for the application server integrate well with the NOS and desktop operating system so that performance is optimized and extra administration duties are diminished. Selecting the correct OS is a balance between performance, flexibility and interoperability with the NOS and desktop OS.

For an RDBMS server, the OS is frequently a UNIX variant. Most RDBMS have been highly optimized to run on UNIX, and the scalability of UNIX allows for growth as the RDBMS grows and requires more system resources. UNIX integrates well with most NOSs, and there is extensive third party support. Many tools such as database monitoring software are UNIX specific. The following table illustrates the approximate market share of the top four UNIX vendors both by number of licenses sold and total revenue:

Rank	Licenses	Revenue
1	Sun Microsystems (21%)	Hewlett-Packard (19.5%)
2	Santa Cruz Operations (19%)	Sun Microsystems (18.2%)
3	Hewlett-Packard (7%)	IBM (11.8%)
4	IBM (5%)	DEC (5.6%)

While Sun Microsystems is the largest independent UNIX vendor (their entire business is based on sales of UNIX and supporting hardware), they have traditionally been focused on Engineering and Scientific applications of UNIX technology. Both HP and IBM are more directly focused on general MIS applications.

NetWare can also be used as a host OS for an RDBMS, though the scalability suffers due to lack of upwardly scaleable hardware and symmetric multi-processor (SMP) support. NetWare is used as a RDBMS server OS most often in workgroups or small to medium organizations.

Microsoft Windows NT Server is a viable OS option for RDBMS and applications, offering a low cost alternative to the more expensive UNIX platforms. Scalability is better than NetWare, but the very high-end options available for UNIX (Sequent, for example), are not yet available for NTS. NTS additionally benefits from its portability to other processor chips (Alpha and MIPS).

OS/2, though it has a small market share as an RDBMS server OS, has lost its initial momentum and is not very scaleable.

Considerations for the Selection of Application Server Operating Systems

Given the state of the market and technologies for Application Server Operating Systems, the following criteria should be considered when making product selections:

An application server OS should:

- Be optimized for the application that it supports. An example is UNIX or NTS as an RDBMS platform, with their ability to support multiple concurrent processes and SMP.

- Interoperate with the NOS to provide transparent access for users. The client machine should not need special drivers and configurations beyond what is needed for basic access to the NOS.

- Support the demands of the application under high loads. The OS should be able to handle stress situations in which load levels are high, something at which a true multitasking OSs like UNIX and NTS excel.

- Aid application administration. One of the benefits of having an operating system such as UNIX or NTS as the application server OS is that support scripts can be created and maintained quite easily with tools provided by the OS. Using an OS such as NetWare could cause difficulty in creating and managing maintenance utilities on the server, requiring the move of maintenance activities to a client workstation to achieve the same level of support.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- County users should attempt to use either NetWare or UNIX. The decision should be based on the requirements of the application (scalability, C/S architecture, etc.). Netware is recommended due to its prevalence in the current CSM environment. Little extra training and support will be required.

- If UNIX is selected, users should attempt to specify or select between HP, Sun, or IBM.

- All others (NTS, OS400, VMS, OS/2, etc.) should be considered only where specifically required.
- These guidelines should be revisited when new versions of alternative application operating systems become available. Specifically, NTS and AS/400 are due to be updated in 1995 and should be reevaluated at that time.

HARDWARE PLATFORM GUIDELINES

Desktop Hardware

Description

The term 'desktop' refers to computers designed to be used by individuals and includes both personal computers and workstations (even though not all workstations easily fit on a desk). Desktops may be stand-alone or connected to a network. Historically, there has been a distinction made between personal computers and workstations based on power and in turn, the kinds of applications they are used to run. Workstations are commonly thought of as high-end machines with extensive calculating or graphics capabilities and are used for such applications as computer-aided design (CAD). Personal computers, on the other hand, are thought of as less powerful computers used for business applications. The distinction between the two is rapidly blurring as technologies progress.

Issues

Guidelines for the selection of desktop hardware should address the following issues and criteria:

- Maximizing compatibility with existing hardware.
- Minimizing investment in specialized hardware.
- Minimizing time and cost of installation and maintenance.
- Minimizing operating system dependence.
- Reducing risk of obsolescence.
- Minimizing cost associated with increasing capacity.
- Maximizing flexibility for expanding capacity.

State of the Market

The market for desktop hardware is dominated by Intel architecture PCs/workstations. With small differences in bus and peripheral support, the decision is where to be on the price/performance curve of the Intel X86 CPU compatible line. The X86 lineup has grown steadily over the years, basically causing the obsolescence of hardware at the rate of 2-3 years. The last three X86 incarnations (386, 486, & Pentium) all work well together running the same OS and applications. With the size and features of the latest applications, however, the push is to move to the fastest platform currently available (currently the Pentium-based systems).

With Intel lowering the prices on Pentium CPUs, the overall system cost for a Pentium-based system is now roughly where 486 systems were last year. While the price of 486 systems are quite attractive, Intel is pushing for the mainstream acceptance of the Pentium and the obsolescence of the 486. Programs compiled directly for the Pentium have a performance advantage. Though there are virtually no applications that take advantage of

this today, this is likely to become important in the ability to run software one to two years from now as the Pentium becomes the mainstream CPU.

One area of interest when comparing systems is the bus technology used. Almost all available PCs support the ISA bus, and most new PCs are equipped with additional bus slots for VLB or PCI compatible cards. VLB is an ad-hoc standard promoted by clone vendors who were attempting to create a standard before Intel delivered its own PCI bus. VLB works well and is inexpensive, but tends to have problems in high end systems that run faster than 33MHz (at the motherboard level). PCI is being adopted by most of the name PC vendors and is also being included in systems that use non-Intel CPUs such as the PowerPC platform. It is important to invest in systems that have commercially viable busses.

Other platforms worth considering include the PowerPC platform being developed by IBM. Systems based around the PowerPC CPU co-developed with Motorola and Apple, are probably going to be performance competitive with Intel Pentium CPU, but will be forced to use OS/2, Windows NT, or the Apple Mac OS instead of the mainstream Windows 3.1 or the soon to be released Windows 95. The PowerPC systems could be a technological success but a marketplace failure, so it is best to wait until the marketplace accepts the systems before embracing them as the client hardware of choice.

The Macintosh line is migrating to the PowerPC architecture, so its fate is tied to the success or failure of the sales of PowerPC systems. The Apple sales of PowerPC based systems are currently starting to pick up, but it is difficult to recommend the purchase of new Apple systems unless there is already an entrenched Mac user community in the organization.

Another concern in choosing the desktop hardware is in selecting the PC vendor itself. PC vendors such as Compaq and Dell are no longer just simple 'clone' vendors as in the marketplace of the 80's; they are driving the market and are often the vendors to watch for trends in desktop and network server systems.

Considerations for the Selection of Desktop Hardware

Given the state of the market and technologies for Desktop Hardware, the following criteria should be considered when making product selections:

- The desktop hardware should support mainstream OS, environments, and applications. For example, it must support Windows and Windows compatible applications. The marketplace support for Windows applications demands that the hardware run them well without a performance penalty. This will be the litmus test for the acceptance of the PowerPC platform in the marketplace. For now, this puts Intel CPU based systems at the top of the list.

- The desktop hardware should support the full range of available peripherals, and those peripherals should have available drivers for the OS used for the system. There should be complete hardware and software support available for the range of tasks that a PC might be called upon to do, including support for multi-media

based software, with the demand for sound cards, CD-ROM drives, and fast video cards.

- The desktop hardware should support an OS that runs standard mainstream applications. If the hardware supports only proprietary or non-commercially viable OS, then the system's ability to support mainstream applications could be compromised, leading to quick obsolescence.

- The desktop hardware should support a standard bus configuration. The hardware should offer at least four ISA bus slots, as well as a minimum of two PCI or other commercially accepted fast bus slots.

- The desktop hardware should have a design that allows for simple hardware alterations, such as adding or changing a hard disk drive. High level of "Plug and Play" functionality should be supported by the vendor.

- The desktop hardware should support standard memory components. The system should not use proprietary memory modules, for these will likely become obsolete quickly.

- The desktop hardware should be compatible with existing applications. If the organization moves to a desktop hardware platform that requires a specific OS such as UNIX, the system may be incompatible with the current applications.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- Users should purchase hardware certified as supported by the desktop operating system manufacturer. For example, if Microsoft Windows is chosen as the desktop OS, hardware should be certified by Microsoft as supporting Windows.

- To maximize the technology investment, the minimum configuration should incorporate an Intel Pentium micro-processor; In no case should a Department consider a system less capable than an Intel 80486/33 or equivalent. This will ensure that the machine will not be obsolete within two years. Organizations should also develop a three-year plan for replacement to prepare for obsolescence. Recycling of machines (i.e. dynamic distribution to users based on needs) should be employed to avoid purchasing less powerful systems.

- As there currently is limited demand for business multimedia, multimedia hardware should be purchased only if required for specific applications. Multimedia components purchased today probably will not support multimedia applications introduced a year from now. Agencies may be able to save money by having the vendor remove any multimedia hardware bundled with the computer.

- Mac, Power PC or UNIX workstations should be avoided unless specifically required for an application. Motif/X terminal or workstation requirements should be met using an X-emulator on Windows wherever possible.

- More specific guidelines generated by the Desktop Solutions Project should be considered.

Network Server Hardware

Description

Network Servers run software which manage access to the network and resources on the network such as printers and disk space. Given their role of serving multiple users and processes, network servers should have significantly greater input/output capacity, expandability for memory and peripherals, and disk space than that of desktops. They also commonly include hardware for fault tolerance (e.g. power failures, disk crashes, memory loss).

Issues

In addition to those for the selection of desktop hardware, guidelines for network server selection should address the following issues and criteria:

- Maximizing expandability of file storage capacity.

- Maximizing expandability of capacity for handling such resources as printers, faxes, etc.

- Maximizing ability to communicate with other networks.

- Maximizing compatibility with existing hardware.

- Minimizing investment in specialized hardware.

- Minimizing time and cost of installation and maintenance.

- Minimizing operating system dependence.

- Reducing risk of obsolescence

- Minimizing cost associated with increasing capacity.

- Maximizing flexibility for expanding capacity.

State of the Market

The marketplace for network server hardware is tied closely to the choice of the NOS. The first criteria is whether or not the hardware is supported by the NOS vendor. In turn, the configurations must be evaluated for performance and stability. The vendor must also be evaluated for support and company stability. The offering of multiple CPUs (and the

SMP support of the NOS) are a consideration. Some of the vendors in this area are Compaq, Dell, Gateway, and ALR. There are also some vendors of high-end specialty hardware such as Tricord.

The trend is toward increasing capacities of the network server machines. There use to be very little difference between the PC on the desk and the PC used as a server. As the market matures, the move is towards very fast and sophisticated systems that make use of components and architectures that were once the domain of minicomputers. Where once there were distinct divisions between the mainframe, minicomputer, workstation, and PC, it is now difficult to make hard and fast divisions between the available hardware as the lines get blurred by the full scale of hardware options. Intel based hardware is used for multi-processor systems and UNIX based workstations are targeted to non-technical users. Highend UNIX hardware is used to replace mainframes, and is also compared to systems such as the relatively low cost Compaq Proliant running four Pentium processors.

Considerations for the Selection of Network Server Hardware

Given the state of the market and technologies for Network Server Hardware, the following criteria should be considered when making product selections:

- Support the NOS of choice. This is the primary reason for having the hardware, so the server machine should support the chosen NOS and be configurable to optimize the usage of the NOS.

- Support fast storage and allow flexible increases in storage capacity.

- Have a large amount of memory capacity .

- Support standard high speed buses (like a EISA/PCI combination).

- Support hardware peripherals such as tape backups.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- Users should purchase NetWare compatible Intel Pentium-based servers.

- Servers should be Novell certified. Novell has a program through which they test servers for compatibility with NetWare. Any server vendor can specify whether their server is certified via this program, and proof of certification should be available.

- Minimum configuration is Intel Pentium/90MHz. This will minimize rapid obsolescence. SMP capabilities are not necessary given that NetWare does not currently support multiple processors.

- Server should include a CD-ROM drive rated "double-speed" or better for server software installation and upgrades.

- Server should be optimized for network server activity (avoid "overgrown" workstations).

- Hardware supported fault tolerance should be included at the level required by the particular user community. Duplexing or Raid 5 should be considered.

- Where centralized tape backup is not used (refer to guidelines for Peripheral Sharing), a tape backup unit should be included.

Applications Server Hardware

Description

Application servers are computers connected to the network which are used to run software applications. Typically, the applications either require extensive computing resources or are used by multiple users. Software which commonly runs on application servers includes database management systems, workflow management systems, e-mail systems, customized departmental applications, etc.

Issues

In addition to those associated with desktop and network server hardware, guidelines for the selection of application hardware should address the following issues and criteria:

- Determining which hardware delivers best scalability of storage and processing capacity at good value

- Providing optimum replacement or migration path toward the target architecture.

- Maximizing expandability of file storage capacity.

- Maximizing expandability of capacity for handling such resources as printers, faxes, etc.

- Maximizing ability to communicate with other networks.

- Maximizing compatibility with existing hardware.

- Minimizing investment in specialized hardware.

- Minimizing time and cost of installation and maintenance.

- Minimizing operating system dependence.

- Reducing risk of obsolescence.

- Minimizing cost associated with increasing capacity.

- Maximizing flexibility for expanding capacity.

State of the Market

The choice of application server hardware is tied directly to the main application being supported by the server hardware and the OS which balances application performance with network integration, ability to be supported by current staff, and other issues. The optimum server for an application such as an RDBMS could be much different from the best hardware to support an application such as Lotus Notes. The application server market does have some highly optimized machines for particular applications such as an Oracle database, but at the workgroup level the machines are often the same machines being discussed for network servers. At the higher end, RISC based UNIX servers are now commonly used. This is rapidly changing with vendors such as Compaq releasing Pentium SMP servers that are challenging the large UNIX machines with impressive performance figures at a much lower price point.

One very important factor when evaluating application hardware is scalability. Given the dynamics of most businesses, it is often difficult to plan requirements beyond 2-3 years. Unlike network servers, where capacity can be easily increased simply by adding more network server machines, application servers are often confined to a single machine or a set of clustered machines and you are forced to change hardware to grow. This is an area that is most important in very large databases that may have many independent custom applications running against them. A machine that housed the application during development may be very slow under loads produced during production use.

Hardware vendors are aware of this and are tailoring their product lines accordingly. An example would be the new Sun lineup of UNIX RISC hardware, where the product line runs the same flavor of the UNIX OS (Solaris) throughout the desktop, workgroup, and enterprise level products. Machines in the workgroup and enterprise level can be scaled up by adding extra processors (8 and 20 respectively) and large amounts of memory. Other vendors such as Pyramid are taking this one step further and offering clustered hardware that make use of parallel server software technology from application vendors such as Oracle. As more and more organizations move mission critical enterprise level applications off mainframes and minicomputers, the ability to scale a machine to the correct levels will become increasingly important.

With the increasing sophistication of SMP CISC-based hardware (using CPUs such as Intel's Pentium), the market will be in a state of flux over the next several years as the performance of these machines becomes competitive with the large RISC-based hardware. The lines between CISC and RISC based machines increasingly will blur as the support for true SMP OS (like Microsoft's NT and SCO UNIX) on CISC machines present price/performance numbers and scalability competing with, and increasingly beating, RISC based hardware with proprietary flavors of the UNIX OS.

Minicomputers such as AS/400s and DEC VAXs enjoy a significant share of the current market and have been the platforms of choice for many large corporations. They also provide the scalability required for application servers. However, these platforms have lagged in providing the 'openness' of the alternatives. On the other hand, they appear to be following the market trends and should be watched.

For applications such as Lotus Notes, the choice of hardware is similar to the model discussed in the network server hardware section. These types of applications are somewhere between an application such as a true RDBMS and a standard NOS.

Considerations for the Selection of Application Server Hardware

The guidelines for selection of application server hardware encompass those discussed for the desktop and network hardware. Given the state of the market and technologies for Application Server Hardware, the following criteria should be considered when making product selections:

The application server hardware should also:

- Support the application of choice. This is the primary reason for having the hardware, so the server machine should support the chosen application and be configurable to optimize the usage of the application.

- Support the OS that optimizes the performance and support of the application. This is very important, because the application will have different performance and support characteristics depending upon the combination of the three factors - application, OS, and hardware.

- Integrate with the current networking strategy. If the application hardware cannot be accessed through the current network, it could have substantial associated costs.

- Offer scalability solutions that support the application. This could be accomplished by adding more processors, memory, and possibly more machines.

- Support fast storage and allow flexible increases in storage capacity.

- Have a large amount of memory capacity.

- Support hardware peripherals such as tape backups.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- The server should be fully compatible with the application server operating system.

- The server should be certified by the operating system vendor.

- Strong integration with the network operating system should be supported. For example, the TCP/IP network protocol and common remote procedure call mechanism.

- Server should include a CD-ROM drive, rated "double-speed" or better for installing and upgrading the server software.

- Hardware supported fault tolerance should match application requirements for availability.

- Options for scalability should be incorporated (expansion slots for additional processor cards, for example).

- Host capabilities should be supported if required for the application.

SYSTEM SERVICES AND FUNCTIONS GUIDELINES

Application Development Tools and Languages

Description

Application Development Tools and Languages will be used to create systems that automate business and functional processes for the County of San Mateo. Languages most commonly used in business applications are either third generation (3GL) or fourth generation languages (4GL) or a combination of both. Examples of 3GLs are C, C++, COBOL, and BASIC. Examples of 4GLs are PowerBuilder, SQLWindows, Access, Paradox, Clipper, and, on the mainframe, Focus. An example of a 3GL that has such an intuitive development environment that it is often classified under a 4GL is Visual Basic.

Tools supplement languages in providing additional functionality for the programmer. Examples are: report generators, CASE tools (e.g. for database design), version control software, ad hoc query tools, database administration tools, compilers, debuggers, testing software, etc. Specific examples are ERwin for generating entity-relationship diagrams and schema, PVCS or Delta for version control, Q+E Database Editor for ad hoc querying and editing of data, and SQL Coder for managing server code.

Issues

- Increasing productivity of programmers and users by providing a varied feature set, enabling complex applications, and complying with industry-wide interface standards (e.g. Motif for UNIX and Microsoft's User Interface Guidelines).

- Maximizing investment in machines and maintain system's viability in the market by supporting a client-server platform.

- Providing flexibility by supporting several relational databases, as well as read/write access to flat files.

- Providing the ability to export and import data from various formats such as spreadsheets, ASCII files, etc.

- Maximizing the value of the investment through the extent of the product's portability across multiple platforms and extensibility of its language and features through the availability of add-ons such as Visual Basic VBXs.

- Choosing a reputable vendor.

- Balancing quality and cost of support.

- Considering the skill set and aptitude of the staff of programmers.

- Seeking evidence that the product is viable in the market, such as sales volume and number of install sites. Also telling is the proliferation of third party tools and add-ons to support and enhance the product, availability and number of training classes being offered, coverage from both trade journals and books, etc.

- Minimizing cost by selecting a language that allows for free run-time distribution (i.e., does not require license fees for users of the application built with the product).

- Assuring that the product is well documented and provides code samples.

State of the Market

Currently, the most popular languages and tools support client-server as a platform where portions of the application are split between the client machine and the server. This serves to provide the best use of equipment and increases performance. Putting the logic directly pertaining to data in corporate databases eliminates the need to re-code the same logic in subsequent applications.

Front-end code handles formatting, user interface, and screen navigation issues. To provide a standardized, easier to use and learn interface to the user, most applications have a GUI (graphical user interface). Back-end portions handle data validation, business rule enforcement, security, and transaction processing issues implemented as database objects such as rules, triggers, and stored procedures. The product must support SQL by either using Microsoft's ODBC, the database's application programming interface (API) such as DB-Library for SQL Server, or a proprietary method of accessing and manipulating RDBMS (relational database management systems).

Most interfaces are now created using a 4GL, and processes that are CPU-intensive are developed using a 3GL. This provides the best of both worlds: the quick development time of a 4GL and the performance benefits of a 3GL. Most major 4GLs currently available are extensible through add-on libraries and execute other programs written in a 3GL. Many 3GLs are adapting the concept of an integrated development environment comprised of multiple tools such as dialog editors, resource editors, screen painters, etc. already found in 4GLs.

Another goal is to use object oriented programming (OOP) techniques and languages to address code re-usability. By creating re-usable objects that can be used for different applications, logic that remains the same throughout all applications need not be rewritten. Selecting tools that support OLE (object linking and embedding) is of primary importance as it allows an application to provide functionality from an existing tool; for example, using a spreadsheet product such as Excel or Lotus to embed spreadsheet functionality.

It is also becoming more and more common for products to come bundled with CASE (e.g. database design tools) and version control tools that track project components, versions, and check-in/check-out status through a central repository (usually a standalone version of a RDBMS). If not bundled, the product being evaluated should be supported by the leading CASE and version control vendors. Other tools that enhance programmer productivity are optimization tools and debuggers. It would be ideal if the language or product selected is supported by as many vendors of these tools as possible.

Many products also come bundled with a standalone or single-user version of a relational database to enable the developer to work at home or on the road without having to

connect to a server. Examples are Watcom with PowerBuilder, SQLBase with SQLWindows, Access tables with Access and Visual Basic, etc.

It is possible to split the available tools into two high-level categories: PC DBMSs and Professional Database Development Tools. The former are targeted primarily at workgroups or departmental applications development; the latter are for larger scale application development. Two vendors, Microsoft and Borland, have risen to the top in the PC DBMS category. There is not such clear dominance in the Professional DB tool category. Vendors in this category include: Gupta, PowerSoft, Microsoft, Knowledgeware, and Symantec.

Considerations for the Selection of Application Development Tools and Languages

Given the state of the market and technologies for Application Development Tools and Languages, the following criteria should be considered when making product selections:

- To improve programmer productivity the product must:

  - be easy to learn, taking into account the skill set and aptitude of existing programmers

  - be well documented and have code samples

  - have easily available and affordable training classes

  - be a 4GL that can call other 3GL programs to optimize portions of applications

  - be able to create "tool-kits" (i.e. function libraries, objects, etc.) that can be re-used on other projects

  - be stable with a proven track record (e.g. not buggy)

  - be created to run specifically for a given operating system, not merely modified to work with a new environment, such as an old character-based tool that has been modified and released as a Windows version. As a specific example, Enfin for OS/2 was stable and regarded as a good product, but the first Windows version was buggy.

  - have a good debugger

  - allow you to save your code as text (as opposed to the proprietary format of the tool)

  - be able to create applications following industry-standard interface guidelines (i.e.. its objects must be appropriate to the operating system it will run on. For example, the application should not look like Motif if it is meant to run on Windows)

  - have tools such as CASE, version control, etc. that support it

  - have a fast and efficient compiler

  - support a multi-programmer/team development environment

- provide support for OLE 2.0 to take advantage of features already found in existing products

- support inheritance

- To maximize the return on investment in machines the product must:

  - support client-server applications by interfacing with SQL relational databases such as Oracle and SQL Server so that processing can be done on both the user's machines and the server

- To provide flexibility the product must:

  - support several relational databases (through ODBC and the database's own API). If a product has its own proprietary interface to a database, ensure that the vendor is committed to keeping up with the database vendor's technology and that the lag is kept to a minimum. Also, with a proprietary interface to a database, the way in which it interacts with the back end should be well-understood so that code can be optimized properly

  - support read/write multi-user access to flat files

  - allow data to be imported and exported from various formats, such as spreadsheets, ASCII files, comma-separated values CSV files, etc.

  - be able to run on several platforms (e.g. Windows and Mac)

  - be extensible through the ability to call DLLs and by having numerous third party products as add-ons

- To provide good performance the product must:

  - be able to create executable files (some products such as Gupta's SQLWindows V5 go a step further and allow development in a 4GL, then creating C code to be compiled into a genuine .EXE)

  - be able to call other .EXEs that can perform specialized tasks

  - be benchmarked with competing products performing the same tasks, using components on the same hardware, using the same network and database server, using accepted benchmark suites such as TPC-C, and comparing the results

  - be 32-bit or soon to provide a 32-bit version

- Ensure that the reputation of the vendor is good by:

  - determining the vendor's track record with other products (especially similar products)

  - checking information gathered from the trade press and consultants

  - reviewing recommendations and case studies from users

  - verifying that the vendor can and will commit to keeping abreast of new features/technology of the product's underlying operating system and database and implement them in future versions of the product

- Product cost:
  - determining the vendor's support plan or plan options and their costs
  - ensuring that there is a large installed base of expertise that you can tap (either the vendor's in-house consulting or other consulting companies)
  - avoiding run-time fees to distribute your applications whenever possible; check also with any third-party add-ons/libraries you may be using
  - check if site licensing is available, if volume discounts can be obtained and if GSA pricing or other contracts can be used to your advantage
  - make sure the costs of additional products for connectivity, add-ons, etc. are considered
  - check the upgrade policy and cost
  - check what software and hardware is required for developers as well as users (e.g., Does any additional software need to be installed? What are minimum hardware requirements?)

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- The choice of tools should depend primarily on specific application requirements.
- The choice should also attempt to maximize compatibility with existing environments. In doing so, compatibility with languages and databases already in place at the County, should be considered whenever possible.
- Small workgroup and desktop application development tool selection should be made from one of the following top four products: Microsoft Access, Borland Paradox, Microsoft FoxPro, Borland dBASE.
- Larger scale application development tool selection should focus on associated issues including: change management & version control, scalability, and database server access.

Database Management

Description

Database Management Systems (DBMS), as their name indicates, are responsible for storage, administration, security and availability of data. Commercially available DBMS have enhanced their repertoire to include data access performance, programmability, connectivity and portability.

While PC Databases like Fox Pro and Paradox can meet the requirements of a very small number of users, the current market trend is *upsizing* from PC Databases to Server Databases like Oracle, SQL Server, Informix to meet the requirements of a workgroup. On the other end of the spectrum, in order to reduce the huge administrative and maintenance costs associated with mainframes, there is a *rightsizing* trend towards the client server approach. However, for systems with extremely large workloads and transaction processing, the mainframe is the platform that can meet those needs.

Issues

Guidelines for the selection of database management systems should address the following issues and criteria:

- Providing the ability to share information across different hardware/software environments and between different business processes.

- Eliminating or minimizing the impact to business in the form of data loss.

- Providing information in a timely manner to make intelligent and competitive business decisions.

- Preventing unauthorized access to business critical knowledge.

- Improving turnaround time in developing and deploying new applications and solutions.

- Minimizing the risk of dependence on specific vendors, products and obsolescent technology.

- Reusability of existing equipment and skills and reducing (rightsizing) costs associated with expensive solutions used previously.

State of the Market

Database:

Although the market currently is dominated by relational databases (RDBMS), object oriented databases (OODBMS) are becoming more prevalent. Applications which require object oriented support down to the database level are using these databases. In fact, many relational databases are making plans to provide object support at the database level. Application software in the client server domain, typically PC/Windows front ends, tend to be object oriented whereas software in the UNIX domain is still mainly procedural (with languages like C). This section focuses RDBMSs and client/server database technology.

Data Integrity and Availability:

- Database Mirroring and File Groups (Oracle7).

- High Availability and Parallel Server (Oracle7, Informix On-line).

Connectivity:

- ODBC, XA, Proprietary Links are now offered with most DBMS vendors to provide connectivity to their databases.
- DBMS also offer a variety of networking protocols. Oracle7 and SYBASE offer connectivity via TCP/IP, SPX/IPX, named pipes and many others.

Database Engine Performance:

- Parallel Execution is the latest buzzword in the RDBMS arena with the ability to use a multiprocessor environment to speed up data access, aggregation, summarization and sorting, operations which were hitherto executed serially.
- Oracle 7.1 supports parallel query, load and index creation.
- SQL Server System 10 comes with a navigation server.
- Informix On-line has parallel query support.
- Scalability in a multiprocessor environment (e.g. Oracle7, and Informix).

Client/Server Performance

- Reducing network traffic by means of batching more data in fewer individual requests.
- Stored Procedures and triggers (Oracle7, SYBASE SQL Server) reduce network traffic by being executed on the server.
- Remote Procedure Calls allow distribution of the workload among multiple servers and other machines on the network. (SYBASE, SQL Server, Third Party software like Netwise, being developed in Oracle).
- Caching and cursor support on the client side.

Object Oriented

- Currently most client tools on the Desktop are object oriented. However, the tools used for database back-end programming still tend to be procedural.
- Databases are moving towards object oriented nature in the long term. However, object oriented databases like Versant have a market niche for applications that need to be object oriented from the data up.

Multimedia support

- Multi media support like BLOBs (Binary Large Objects) is still evolving in the RDBMS arena. Specialized multimedia databases like Mind's Eye can handle this better currently.

Decision Support

- Multidimensional Databases for hierarchical data (ESSBASE, Red Brick).

- Parallel Query support in relational databases.

Database configurability and programmability

- SQL support and extensions (most DBMS).

- Cost Based Optimizer (To tune SQL automatically. Supported in Sybase, SQL Server, Oracle7).

- Stored Procedures (SYBASE, SQL Server, Informix On-line, Oracle7).

- Database Tools:

    - SQL Server comes with SQL Administrator and Object Manager

    - Third Party Tools like TSReorg, Desktop DBA, SQL Studio, SQL Coder

    - Built-in Database Monitoring Tools (SQL Performance Monitor for SQL Server)

    - Third Party Database Monitoring and Exception Notification Tools (Patrol, DB Vision)

- Customizability for low workloads and small configurations to heavy workloads and large configurations (Oracle7).

Application Development Tools

- Tools supplied by the DBMS vendor (CDE from Oracle, Wings from Informix).

- Third Party Tools (PowerBuilder, SQL Windows, Object View, Visual Basic/C++).

- CASE and Data Modeling Tools (Oracle CASE, Logicworks ERwin, Asymetrix Infomodeler, and LBMS).

Considerations for the Selection of Database Management Systems

Given the state of the market and technologies for Database Management Systems, the following criteria should be considered when making product selections:

Data integrity and data loss prevention are critical to any information system. The range of features offered by a DBMS in this regard should include:

- Ability to mirror and store multiple on-line copies of data. There are different ways of achieving this:

    - Support for disk partition or disk mirroring at the operating system level.

    - Support for mirroring critical database files by the DBMS.

- Support for backups and flexibility to provide varying degrees of backup including:

  - Full and incremental backups.

  - (On-line) Backups which do not require downtime from the database depending on the specific requirements.

  - Speedy recovery features.

  - Administrative interface to backups, either proprietary or third party.

  - Ability to do high volume backups to stackers, optical devices, etc.

- At the high end of reliability, a DBMS should have high availability features such as:

  - The ability to deal with hardware failure by providing a replicated database on a second machine in the form of:

    - Distributed Database

    - Parallel Server

  - The ability to use high availability features and hooks provided by the operating system.

To ensure good performance, a DBMS should have the following features:

- Automatic configurability to handle all the workloads expected.

- Reduction of network traffic like stored procedures, cursors and network packet sizes.

- Scalability or enhanced performance in a multiprocessor environment.

- Ability to bulk load data into the database at a high throughput.

- Industry standard benchmarks like TPC-A and TPC-C are initial indications of performance of server databases. However, performance in benchmarks which emulate the system for which the DBMS is considered will give a better indication.

- Ability to provide high concurrency in case of on-line transaction processing applications in the form of:

  - Row level locking.

  - Support for multiple *threads* of execution in the database.

- Capacity for decision support/reporting applications in the form of:

  - Parallel query features to enhance query performance in a multiprocessor environment.

- Snapshots or table replication features to off-load decision support/reporting to other servers.

- Cost based optimization to automatically tune data access.

- Market proven ability in features such as sorting and aggregation, indexing, etc.

In order to ensure good connectivity and interoperability a DBMS must have the following features:

- Support for open standards which are applicable to the system such as ODBC, XA, etc.

- Provide links to the DBMS over all major platforms.

- Support gateways to mainframe databases.

- Support for a variety of networking protocols (Named pipes, SPX/IPX, TCP/IP, etc.).

- Provide client tools to operate the DBMS on the major client platforms (Windows, Motif).

In order to ensure good programmability, a DBMS must have the following features:

- Support for SQL and strong extensions to SQL in case of an RDBMS.

- Support for 3GL control languages and embedded SQL to allow strong, flexible programming.

- Support for creation and management of stored procedures.

- Declarative referential integrity.

- Support for remote procedure calls in a distributed environment.

- Provide an API for Database programming.

To provide a good return on investment a DBMS should have the following features:

- Suitable licensing policy which does not incur excessive cost. This could include either:
  - Concurrent use.
  - Named users.
- Ability to reuse existing skills in the form of:
  - Programmability with the existing applications and adherence to standards (like SQL).

- Programmability with languages that are part of the current install base (like C & COBOL).

- Availability of training classes and certification programs.

To ensure flexibility and platform independence, a DBMS should have the following features:

- Portability. The DBMS must be able to run on a variety of platforms with no significant loss in functionality and features.

- Platform independent data storage mechanisms.

- Data migration suite consisting of:

  - Bulk load features for large amounts of data.

  - Database transfer features to move sets of related data with minimal administration.

  - Proprietary or third party tools to transfer data with other Data management software.

- For administration and security purposes a DBMS should have the following:

  - Proprietary or third party tools to administer the database.

  - Tools to monitor the database and provide notification in case of emergency.

  - Security mechanisms which allow administration on a per user or a group basis.

  - A mechanism to audit database actions and deal efficiently with audit history.

  - Performance monitoring tools.

  - Extraction/DBA Tools.

Depending on the type of data the following should be considered:

- DBMS support for multimedia. Does the DBMS support BLOBs (Binary Large Objects) and does it have an API for handling images.

- For multidimensional data, the ability of the DBMS to do data transformations and maintain hierarchy of information is important.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

There are two major categories of database products which are specified for these guidelines. They are PC DBMS's, for stand-alone and small workgroup applications, and SQL-based RDBMS Servers, for larger and more complex applications. The PC DBMSs specified here overlap with those specified in the Application Development Tools and Languages section.

- PC DBMS selection should be one of the following products: Microsoft Access, Borland Paradox, Microsoft FoxPro, Borland dBASE. Key considerations should be ability to scale upwards via access to database servers.

- SQL-based RDBMS Server selection should be one of the following products: ORACLE7, Sybase SQL Server System 10, Informix, Gupta SQLBase. Informix' announcement that NetWare will not be supported by future releases might be a factor if Novell is the selected server OS. Gupta SQLBase is currently in use in the County, but should be considered only for small to medium-sized applications since current versions do not scale up as well as the other products.

- The selection of a business application may dictate which DBMS is used, since the software vendor may require a specific brand of database.

Decision Support Tools

Description

Decision support tools are products used to extract, analyze, and format information for decision making. With the increasing power of the desktop, the importance of these tools has increased dramatically. Today reportwriters, spreadsheets, statistics packages, and executive information systems can directly access corporate data.

With this power at the desktop, has come a change in the role of MIS. Traditionally, MIS has provided reports and data at the request of end-users. MIS professionals assembled the data needed for user requests, designed queries and reports, and provided hard copy results or a spreadsheets back to the user for decision-making. This often led to huge back-logs in satisfying user requests, to the point where the information was no longer valuable by the time it was received.

Modern MIS departments are today redefining their role. They remain the collectors, archivists and guardians of corporate data, maintaining its quality and integrity. However, rather than servicing information requests, these departments see their role as making the data accessible at the desktop for retrieval by end-users. Seldom does this mean providing direct access to operational systems. Rather, this means staging the data

at locations and in a format that is readily accessible and understandable. Because of the flexible access provided by SQL databases, this staging is often done by replicating or downloading data to dedicated relational database servers for decision support. This off-loads the burden of query processing from the operational transaction systems.

In addition to staging the data, MIS must provide the plumbing and infrastructure (middleware) for desktop tools to access decision support data. Minimally, this means establishing a SQL access API at the desktop, either through standards such as the ODBC (Open Database Connectivity) or through the RDBMS vendor's proprietary interface. In the interest of easing administrative support, it may also be desirable to set standards as to supported query tools, reportwriters, spreadsheets, and statistical packages.

Issues

Guidelines for decision support tools should recognize the new role of MIS as a provider of infrastructure and data access. Successful decision support systems should address the following issues:

- Standardizing on both back-end databases and a service layer that allows a wide variety of tools to plug in (OLE).

- Supporting and testing an agreed upon set of client access services (OLE), including DLL version levels that decision support clients MIS will maintain at the desktop.

- Recognizing the need for decision support data to be maintained apart from production systems, if end-user interactive query and reporting are to be provided.

- Recognize the need for data be staged in denormalized fashion for successful access by end-users. Some have called this the establishment of "datamarts" as opposed to normalized "data warehouses" where data is archived and cleaned.

- Protecting systems from the "runaway queries" of end-users.

- Establishing security guidelines.

- Agreeing on standards for the basic tools: reportwriter, spreadsheet/charting, statistical analysis, and EIS displays can greatly reduce the administrative cost of keeping this highly diverse set of tools and interfaces compatible with each other.

State of the Market

Report Tools

End-user reporting tools are available from Microsoft (Access), Borland (Paradox, ReportSmith), Lotus (Approach), as well as established RDBMS vendors Oracle (SQL*Report Writer), Sybase (SQR) as well as a host of other vendors. Of these, Access provides a good blend of ease-of-use together with the power and script language capability needed by developers. Concentric's R&R has been providing standalone

reportwriters for years, and has a Windows offering. For industrial strength reporting needs, as well as cross-platform support for both Windows and UNIX, Oracle SQL*ReportWriter and Sybase SQR can tackle the toughest jobs.

Spreadsheet/Charting Tools

Today's two leading spreadsheets more than adequately address most decision support and EIS requirements. MS-EXCEL and Lotus 1-2-3 provide built-in query tools, ODBC support, cross-tab wizards, dialog box editors, powerful script or macro languages, OLE 2.0 embedded object support, and a book-like metaphor for easily building multi-screen EIS like applications. Either makes an excellent decision support choice.

Statistical Analysis Tools

SAS for Windows, SPSS for Windows, and StatGraphics are several good candidates for statistical analysis. Although SAS leaves something to desire in terms of ease-of-use in its Windows interface, its power and features for statistical analysis remains unequaled.

EIS Tools

Dedicated IS tools provide a point and click interface to charts, graphs, and tables drawn from decision support data. Their special capabilities such as support for "alarms" and notification allow them to act as sentries watching for anomalies in data. However, most of these same capabilities can be implemented in modern spreadsheets, along with better looking graphs, more powerful statistical functions, and well-known and supported script languages. The choice of an EIS, such as those offered by Information Resources, Pilot, IMRS, or EssBase is often motivated by a special analysis need. Chief among these is the need to slice and dice data stored as a multidimensional cube. Multidimensional databases are a instance of the "data staging" requirement stated above.

Considerations for Decision Support Tools

Given the state of the market and technologies for Decision Support Tools, the following criteria should be considered when making product selections:

Report Tools should as a general rule support the following:

- Two pass reporting for calculation of percent of totals at the detail level.
- Crosstab reports.
- Script language and ability to reference all report objects (fields, totals) directly in mathematical calculations.
- Ability to pop up dialogs asking for report-variables such as "begin-date" and "end-date" without coding.
- OLE 2.0 embedded object support for pictures, graphs, etc.
- Built-in charting of cross-tab values.

- Dynamic formatting based upon report values.

- Multiple queries per page of output.

- Support for ODBC.

Spreadsheet/Charting Tools Guidelines
- ODBC support.

- Simplified query tools built-in for defining data extracts.

- Crosstab support.

- OLE 2.0 support.

Statistical Analysis Tools Guidelines
- ODBC Support.

- Cross-tab Support.

- Statistical Analyses relevant to application.

EIS Tools Guidelines
- Should be justified relative to building the same application using a spreadsheet "Book" of tabbed pages.

- ODBC support.

- OLE 2.0 support.

- Strong script language such as Visual Basic.

Specific Guidelines

Rather than specifying specific tools for decision support, an architecture for supporting decision support activity was embraced. This architecture is frequently referred to as a three-tiered database architecture. Separate decision support database servers are implemented to house "snapshots" of data which are constantly being extracted from transaction processing servers. Generally the decision support servers will include a common SQL-based RDBMS (ORACLE7 or SQL Server System 10, for example). Transaction processing servers include both SQL-based RDBMSs and older legacy database technology (CA-Datacom or VSAM, for example). Important characteristics of decision support tools which are purchased for the three-tiered environment are:

- Support both the transaction and decision support servers.

- Support data dictionary (catalog) caching.

- Control of "runaway" queries.

Document/Imaging Management

Description

Document Management products enable the sharing and storing of documents among multiple team members. Usually, these products also come with a workflow module or in some cases, workflow software may come bundled with document management products. Regardless, these two products should be evaluated keeping in mind that if they are not integrated, they should be compatible.

Documents consist of (but are not limited to) text and images. Compound documents should be supported. The movement of related documents through the network should also be tracked.

Issues

Guidelines for the selection of Document and Imaging products should address the following issues and criteria:

- Enable document management tasks such as version control, security, archival, quick and reliable access.
- Provide for document tracking through routing functionality, handling of documents including compound documents movement across the network, audit changes (who and when), document status reports, activity statistics.
- Must be able to track documents, its components (if a compound document), and other files related to it by project.
- Must be able to handle text as well as binary data (images, sound, etc.).
- Must be flexible to handle changes to business requirements by being extensible.
- Must support multiple platforms (Mac, Windows, DOS).
- Must support the most common industry-standard compression/decompression methods.
- Support concurrent read access to documents.
- Support multi-user write access to documents.
- Compatibility with various scanners, optical jukeboxes, OCR readers, and other peripheral devices.
- Must be easy to use and administer.
- Must have fast retrieval of multimedia components.
- Must have good text searching capabilities.
- Must integrate well with existing network operating system.
- Improve productivity of workers.

- Allow for flexibility to handle changing business needs.
- Paper reduction.

State of the Market

There is a trend for document management and workflow products to be integrated or at least compatible. Generally, they can be implemented on a client-server platform. For example, one machine serves as an image server, another as a database server, etc. Prices vary from $300 to $50,000.

Many products which have been available for some time, run on a particular OS. The trend, however, is that vendors are providing versions that can work across multiple platforms. The most important combination being DOS, Windows, and Mac clients. Also, better integration with the network operating system is becoming vital. Novell offers its own imaging functionality in NetWare 4.x.

Products can be classified into two categories:

- "Complete solution" products that offer their own interfaces and provide form designers and scripting languages to allow for customization. Having an API is ideal. Examples of products with APIs are Watermark (note there are several products within Watermark), Keyfile, Enterprise Messaging Server, Jetform. Examples of "complete solution" products are Sigma's Omnidesk, Intergraph's Document Manager, OptiDoc, Documentum, etc.
- Tool-kits which are APIs that provide the functionality but allow shops to create their own document management software. Examples are KIPP Toolkit for Visual Basic, Diamond Head's ImageBasic, and Metafile Information Systems Metaview Imaging control.

Considerations for the Selection of Document and Imaging Management Products and Components

Given the state of the market and technologies for Document and Imaging Management, the following criteria should be considered when making product selections:

Provide core document management functionality:

- Archival scheme that meets organization's requirements; look into products that can take advantage of HSM (Hierarchical Storage Management) technology.
- To facilitate archival, security, document tracking, the product should be able to take advantage of the operating systems features. This may mean that products that specialize in a particular OS may be worth looking at as opposed to those that can run on several different operating systems. The advantage of tight integration with the OS is that security/version control/etc. are less likely to be bypassed by users who access documents outside the document management system.
- Version control.

- Check-in/check-out.

- Multi-user access.

- Security.

- Efficient and flexible search mechanism.

  - partial words

  - related words (synonyms)

  - allow user to specify search criteria

  - on-line catalog of topics/projects is browsed to minimize network traffic

  - full text as well as profile searches

- Support for industry-standard compression schemes (this simplifies things but is worth taking a look at the advantages/disadvantages if a product has its own proprietary scheme).

- Use of a standard relational database such as Oracle or SQL Server. The advantage of this is for extensibility. It will be easier for other products outside of the document management system to access data if necessary.

- Must be compatible with several hardware devices such as scanners, jukeboxes, OCR, tape libraries, color printers, scanning compression cards, etc.

- Must handle concurrency issues well (must issue graceful warning if a user tries to update a document in use by another user).

- Should have document reproduction capabilities.

Provide core document tracking functionality:

- Must be able to track movement of documents through the network (should be well integrated with NOS).

- Must be able to track all components of compound documents.

- Must have notification mechanism to detect upgrades (e.g. if the spreadsheet portion of a document was created using Excel 4.0 but the current version has been upgraded to v5.0 and assuming it wasn't compatible, it should notify the administrator). This is important ,especially if the organization wants to keep extremely old documents on-line and still view them.

- Must be well integrated or highly compatible with workflow management software.

- Must provide current status of documents as they are routed.

- Must allow for annotations, redlining, and highlighting to be added to the original documents (even voice comments).

- Must be able to handle multimedia and BLOBs.

- Must have version tracking capability: an audit trail of most recent changes keeping at least 5 previous versions (although some products can have 99!) as history and restore from any of the versions a user specifies.

- Must allow the restriction of editing previous versions of a document.

- Must be able to track all documents and its components by project.

- Must support sharing of files on a WAN.

- Must support UNC names vs. hard-coded paths to ease tracking (i.e.. must be able to handle location changes of documents).

- Must keep tracking information in a relational database that can easily be queried through third-party tools. If a product uses its own proprietary database, the data must be available not only as reports but as ASCII files.

- Must provide status reports as well as customizable reporting functionality's.

- Must track last person who changed as well as last date changed.

- Must facilitate workgroup tasks by interfacing with other software like Notes or white board software.

Improve productivity of workers:

- Product should have user-friendly administration and installation procedures since most likely a user will be administering it as opposed to MIS.

- Must be integrated with e-mail.

- Must support MAPI or VIM depending on OS used at CSM.

- Must be able to make changes to documents on the road and integrate/reconcile changes automatically at the office.

- Must be an enterprise-wide standard, otherwise it may not be used; look for products that can handle more than one library grouped by department for example and have multiple projects within library.

- Must provide support for OLE to allow workers to perform in-place editing, drag and drop, etc. (this is where the version of the software needs to be tracked) This improves productivity because the user doesn't have to go in and out of apps and search for software by knowing its exact path.

- Must be able to support multiple platforms such as DOS and Windows (big issue if implementing organization-wide basis since not all departments may have the same OS).

- Should have image manipulation features like rotation, scaling, saturation, picking rectangle, etc.

- Must be well documented.

- Must have excellent support.

Flexibility to handle changing needs:

- There are two options, picking a product that can be customized or using libraries/tools that specialize in document handling custom-build your own.

- Must use relational databases that allow access to data through SQL.

- Should come with a scripting language and form designer to allow administrator to customize.

- Should support a common API so it can be integrated with other tools and languages to handle more specific needs within the organization.

Specific Guidelines

It was identified that the Document/Imaging Management market is relatively immature and the County does not have substantial investment in this technology. General recommendations for agencies interested in Document/Imaging Management applications were:

- Core technologies for Document/Imaging Management should tie in with other guidelines to facilitate integration. In particular, the database, workflow, and messaging components should be considered.

- Any package should provide a Microsoft Windows-based user interface.

- Appropriate peripherals should be purchased (e.g. large monitors)

E-Mail and Messaging

Description

Electronic mail (e-mail) allows a person to create and send a message to another person or group via the computer. Simple e-mail systems allow users on a single mainframe computer or single LAN to send messages to other users connected to the same mainframe or LAN. In more complex systems:

- users can send e-mail to other computers and networks - in the same organization, the same type of mail system, or any mail system in the world

- users can send the e-mail as fax if the other person is not part of the computer network

- users can specify an electronic "routing slip" so the mail goes first to several users in a specified order

- users can send e-mail from within other software packages

- software packages can send e-mail directly to the user based on some business event

For this discussion, e-mail refers to the user interface for creating and reading messages from other users and programs. Messaging is the behind-the-scenes technology of how the e-mail gets transferred between users. Selecting an e-mail system means a choice of messaging technology. Many of the differences in features provided by an e-mail system depend on the underlying messaging technology.

Issues

Guidelines for the selection of e-mail systems should address the following issues and criteria:

- Providing a user interface which is easy to learn and use.

- Maximizing variability of message format: whether messages are simple text, or can include bold, underline, different fonts, etc.

- Attaching files and including OLE objects.

- Providing a foundation for structured messages - forms, fill-in fields, and validation.

- Minimizing life cycle cost of software per user, including purchase, installation, support, and hardware such as servers and gateways.

- Allowing convenient, cost-effective scaling up of the message system to many users on many systems, including both hardware and administrative time.

- Maximizing the ability of the user to check their mail from many places - stations within the office, from home, on the road.

Guidelines for the selection of messaging systems should address the following issues and criteria:

- Maximizing the number of other messaging systems to which the message system can communicate.

- Maintaining connectivity to the existing set of e-mail users.

- Adhering to a messaging standard which is supported now and in the future by many vendors.

- Providing message security, so messages can be read only by the intended user.

- Providing flexible routing choices: to many users, to named groups of users, and routing to a set of users in a user-specified order.

- Maximizing connectivity to other software packages besides the e-mail interface, such as allowing mail to be sent directly from a word processing document.

State of the Market

E-mail and messaging systems have been evolving for a long time. The progression has been:

- host-based systems running on mainframes and minicomputers (IBM's PROFS and OfficeVision, *sendmail* and the SMTP protocol on UNIX), to
- file-sharing based systems in the earlier period of LANs (cc:Mail, MS Mail, WP Office), to
- client-server applications which will run on a LAN or WAN (Lotus Notes and VIM, Novell's MHS transport protocol, Microsoft's announced MS Exchange).

All of these systems remain in active use, which makes it important that an enterprise-wide e-mail system be able to communicate with dissimilar packages. There are gateway software packages available to facilitate this transfer.

In recent years, the most active software development has been in the graphical user interface packages for Windows. Competition occurs at both the e-mail presentation layer and on messaging protocols. The current picture is complicated. There have been several competing messaging protocols: MAPI from Microsoft, VIM (Vendor-Independent Messaging) from a group of vendors led by Lotus, MHS as a transport from Novell, plus inter-networking protocols and standards such as SMTP and X.400. Microsoft has made MAPI important by adding MAPI functionality to their Windows packages, such as the Send function in MS Word and Excel, and adding MAPI functionality to the set of functions supported by Windows 95. They have also defined an Extended MAPI for more complex messaging and workflow transport. For cross-platform systems, a simple standard named CMC (Common Messaging Calls) was developed by the X.400 API Association (XAPIA). CMC can be used instead of simple MAPI, and replaces the simple messaging functions of VIM. Finally, Lotus has stated they are developing a VIM-MAPI layer to let VIM applications use MAPI.

Given the above, especially noting that Microsoft is including MAPI functionality in the next version of Windows, any e-mail and messaging systems chosen should utilize CMC or MAPI. For communication with non-Windows systems, X.400 and SMTP gateways need to be available. With the growth in LANs and inter-networking, common standards have become much more important for messaging. As with other technical arenas in the PC industry, the competing systems will probably coalesce to a single standard over the next few years.

According to Word Perfect, as of April 1994, the approximate percentages of LAN-based mailboxes by email vendor is as follows:

WordPerfect Mail	30%
Lotus cc:Mail	30%
MS Mail	23%
Other	17%

Considerations for the Selection of E-mail and Messaging

Given the state of the market and technologies for E-mail and messaging, the following criteria should be considered when making product selections:

To maximize user and system administrator productivity:

- The e-mail system should have an intuitive, easy to use interface to minimize training and learning time.
- Installing and setting up new users should be easy.

The e-mail presentation should include a rich set of presentation features:

- Text formatting: bolding, underlining, indentation, etc.
- File attachments.
- Objects embedding: spreadsheets, word processing documents and graphics can be embedded in the message and launched by the user when they receive the message.
- Definition of forms by the advanced user (not programmers).

To provide extensibility:

- The messaging system should have an API to allow custom application programs to send messages.
- Messaging system should have an interface to MAPI.
- The messaging system should support forms with fields defined by the programmer.

To be scaleable across the entire enterprise:

- The messaging system should use a client-server architecture.
- It should be possible to administer the list of users and addresses both centrally in a single repository and also hierarchically by organizational unit, as appropriate.

Provide security:

- The messaging system should provide encryption and digital signature options.
- The e-mail and messaging systems should allow for communication with the host operating system for user IDs and password verification.

- Provide long term viability:

The vendor should provide a long-term commitment to maintaining compatibility with the evolving messaging standards.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- Future purchases and upgrades should be to Novell's GroupWise (formerly WordPerfect Office) or to Microsoft Mail.

- Scheduling and other extended features beyond messaging are not uniformly available on all products. The need for extended features may dictate which e-mail product is selected.

- MAPI support in all software technology should be considered

- Gateways should be established between existing mail systems.

- A gateway for Internet mail should be implemented.

- The County should commission a separate project to develop a coherent e-mail strategy.

Middleware

Description

Middleware is a broad category of software products that facilitate connectivity between user applications and data sources. There are a variety of functions or capabilities from which any given piece of middleware may be comprised. Examples of these capabilities include:

- A translation engine to convert SQL statements to a required syntax

- Interfaces to different network protocols

- An API to simplify access to different DBMSs

Specific examples of middleware products are ODBC drivers and gateways to enable access to DB2 on an IBM mainframe. These products are generally produced by database vendors or independent middleware vendors

Another example of middleware are two products from Trinzic Corporation. InfoPump and InfoHub are designed to address the problem of users accessing data on heterogeneous platforms. InfoPump extracts data from a wide variety of easily accessible data sources and loads the data into specified data targets. InfoHub provides an interface to harder to access data sources like IMS and VSAM.

Issues

Guidelines for the selection of middleware should address the following issues and criteria:

- Significant complexity of Client/Server technology and "Open" Systems

- Small size of many vendors

- Rapid product upgrade releases

State of the Market

The middleware market is inherently dynamic and problematic. This is because the technology primarily focuses on connecting disparate technologies. Different specific middleware products highlight particular problems.

ODBC is a middleware technology which attempts to provide a standard API for accessing SQL-based databases. While the goal is noble (and potentially useful), the technology creates a least common denominator effect between the different databases. Each different target database may have many different API calls and yet ODBC includes only those calls that are common amongst the different databases.

EDA-SQL (Information Builders, Inc.) has the same problem described above. In addition, its vendor has to support so many data sources that they have difficulty keeping up with new releases of database products. The result is that organizations using EDA-SQL may not be able to upgrade their databases as quickly as they might otherwise want to.

Considerations for the Selection of Middleware

Given the state of the market and technologies for Middleware, the following criteria should be considered when making product selections:

- Potential for use of the particular technology to address multiple needs.

- Avoid technologies that incorporate software or hardware that does not meet other guidelines within this technology architecture.

- Avoid least common denominator phenomenon whenever possible.

- Vendor size and capabilities adequate to ensure longevity

Specific Guidelines

Middleware is unique among the technology areas covered in the architecture. As opposed to other technologies, middleware is not a goal. Rather, it is a necessary "evil". Generally, it is required to address inadequacies in other technology components or to address problems with migration and backward compatibility. CSM's acquisition of middleware products should be needs driven, with strong consideration of the other guidelines. Some general ideas which should be followed are:

- Where middleware is introduced as result of these guidelines, the resulting middleware should abide by the guidelines.

- Multiple uses for middleware products should be identified whenever possible.

- Consider decision support tier as a viable option to middleware (for data access issues).

On-line Information Sharing

Description

On-line information sharing software facilitates the distribution, sharing, and discussion of on-line information. Both structured and unstructured information can be shared. Structured information has traditionally been stored as fields in a database. Unstructured information includes text documents, drawings, images, voice notes, and video. Unstructured information is often difficult to index directly, yet can be rapidly retrieved or traversed when organized into: (1) a logical hierarchy, such as a table of contents, (2) a set of file cabinets and folders, or (3) hypertext. Information sharing products help to capture the knowledge and procedures of an organization and publish it for others.

Modern information sharing systems combine messaging and database technology to support distribution, sharing and discussion of 'information objects'. A word processing document, a spreadsheet, a database report, and scanned magazine image may all be published in the infobase. When viewed, these 'objects' know which software to run in order to display themselves. An Excel spreadsheet will start Excel and display itself, for example.

Issues

Guidelines for the implementation of on-line information sharing systems should be set with the intention of:

- Furthering the capture and publishing of organizational knowledge and practices.
- Improving communications in areas such as case management by facilitating the capture of discussion and decisions.
- Integrating info-sharing and discussion systems with traditional data systems.
- Ensuring cost-effective implementation over the network through distribution or replication of the infobase to remote sites or multiple sites on the wide-area network.
- Minimizing administration and technical support.

State of the Market

At this time, the undisputed leader of info-sharing products is Lotus Notes. No other package today begins to supply the set of features described above. Unfortunately, Notes today rests upon a difficult to scale database and a nearly proprietary messaging interface

(VIM). Lotus recently announced an agreement with Oracle corporation that should put Notes on a stronger foundation within the next two years.

Also, over the course of the next year, competing offerings are likely from two sources, Microsoft, with its new client-server email system called MS EXCHANGE, and Oracle with its document and text retrieval products. MS Exchange will support PUBLIC FOLDERS for mail and other documents, and will automatically replicate these folders to servers throughout the enterprise. COLLABRA's SHARE, a third-party add-in, will provide discussion threads. Whether Exchange will integrate a forms facility remains to be seen.

Oracle is expected to enter this marketplace as well, both through its relationships with Lotus, and its own direct offerings. Few details of the Oracle product have been released at this time.

Considerations for the Selection of Information Sharing Products and Components

Given the state of the market and technologies for Information Sharing, the following criteria should be considered when making product selections:

In order to further the capture and publishing of organization knowledge and practices, on-line information sharing systems should address the following:

- Be able to store and retrieve structured and unstructured information.
- Three types of organization should ideally be supported:
  - Hierarchical folders
  - Indexed key search
  - Indexed text search
- Allow users to subscribe to sections of the infobase, and be notified of new information within their interests.
- Should support a common interchangeable document view-only format such as RTF, ACROBAT, or REPLICA. Also, HTML (Hypertext Markup Language) and SGML (Standard Generalized Markup Language) have been announced for upcoming release.
- Should support versioning of documents.
- Should fully support discussion threads by topic, with the ability to manually edit the threads and re-arrange topics.

In order to provide structure to discussions, the on-line info-sharing product should:

- Easily allow the creation of simple forms based formats.

In order to assure integration with existing data sources, on-line info-sharing sharing systems should:

- Support the storage, distribution, and replication of OLE objects, such as spreadsheets, reports / queries, word processing documents, etc.

In order to ease administration, on-line info-sharing systems should:

- Employ a security scheme to manage access to topics within the infobase as well as individual documents. The ability of this security system to parallel the LAN or DBMS security system is a plus.

- Provide for built-in replication across servers, so that remote offices may have their own up-to-date copy of the infobase.

- Should be able to provide an audit trail of changes to the infobase.

- Should utilize or provide gateways to the standard email system for implementing subscription and discussion.

Specific Guidelines

It was recognized that the Information Sharing market is relatively immature and the County does not have substantial investment in this technology. General recommendations for agencies interested in Information Sharing applications are:

- Look closely at the administrative functions with an eye toward the distributed vs. centralized administration capabilities.

- Security requirements of the application should be fully supported by the technology.

- The work of the Internet Advisory Group and the existing BBS project should be incorporated into these guidelines.

- Any purchases of information Sharing technology should incorporate the other technology area guidelines.

Peripheral Sharing

Description

This area of System Services incorporates technology that facilitates two types of activity. The first is the ability for users to easily share the various types of files that they use or create. Examples of such files would include: letters, spreadsheets, presentations, and application executables. The second activity is the ability for users to access shared peripherals. Examples of such peripherals would include: printers, fax machines, scanners, and modems.

This technology area overlaps some other areas. For example, network operating systems frequently provide some of the aforementioned file sharing capabilities. Additionally,

document and workflow management are complex extensions layered on top of basic file and peripheral sharing technology.

There is already a significant amount of technology in place at the County that has to be taken into consideration when making decisions about implementing new systems. It is also important to realize that file and peripheral sharing are underlying technology services that will greatly impact the effectiveness of higher level applications. Therefore, in-place technology cannot ultimately dictate technology decisions in this area.

Issues

Guidelines for the selection of peripheral sharing technology should address the following issues:

- Existing investment in peripheral sharing technology (past):
  - Network Operating Systems
  - Printers
  - Fax Gateways
- Compatibility with other technology architecture components (future):
  - Document Management
  - Workflow Management
  - Application Development Tools and Languages
- Broad range of file types (letters, spreadsheets, graphics, text, binary).
- County goals to reduce use of paper.
- Remote access by County users.
- Requirements for sharing with non-County organizations.
- Various security requirements.
- Administration overhead.

State of the Market

The file and peripheral sharing market has been dominated by Novell for the past ten years. Their NetWare network operating system provides both file and printer sharing out of the box. In addition, third party products, which provide shared access to a broader set of peripherals (fax machines, modems, and mass storage devices, for example), are available. An example of one of these third party products would be the Castelle FaxPress server for NetWare.

Considerations for Peripheral Sharing

Given the state of the market and technologies for Peripheral Sharing, the following criteria should be considered when making product selections:

- Minimize number of interfaces to different file types.

- Minimize number of interfaces to different peripheral devices.

- Compatibility with NetWare communication mechanisms (SPX/IPX, for example).

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- Peripherals should be connected directly to the network whenever possible. In particular, new printers should be directly connected to the network.

- A CD-ROM jukebox should be considered to facilitate CD sharing.

- Peripherals that allow incoming information must follow CSM security guidelines.

Remote Access

Description

The term Remote Access covers a range of hardware and software configurations which allow users to access the organization's network servers, application servers, host systems, and other LAN or WAN resources from locations without a permanent connection to the WAN.

The County can provide remote access to applications, documents and data, or e-mail and messaging. Host terminal connections via modem, PC remote control, remote LAN node, and dial-up e-mail gateways are all examples of remote access. Each of these modes of access provides different levels of functionality, performance, and security.

While remote access techniques for terminals accessing host based applications are well established, remote access to LANs is still a rapidly evolving area which lacks strong standards.

Issues

Guidelines for remote access should address the following issues:

- How to support tele-commuting.

- How to improve communication with contractors, consultants, and business partners.

- How to provide mobile access to data and applications.

- How can systems and data be protected from unauthorized use or abuse while allowing remote access.

- How to cost effectively support remote access in a multi-vendor, multi-platform environment.

- What remote access choices will provide maximum long term value in the rapidly changing technical environment.

- How to minimize administration and technical support required for remote access.

- How does remote access affect software licensing.

- What is the minimum required hardware and software for remote users.

- Which aspects of remote access require central administration and control, and which can be managed independently by workgroups.

State of the Market

Functions Provided By Remote Access

The following table describes some of the main functions which can be provided via remote access. There are several remote access methods (described below) which provide each of these general classes of functionality.

Function	Description / Comments
E-Mail	Allows exchange of messages and attached files with other e-mail users. Leading e-mail packages provide a specialized remote access capability just for e-mail.
File Transfer	Allows remote users to get files from and store files on network servers or host systems. Typical uses are remote editing of word processing documents, or exchange of CAD drawings with an architect or contractor.
Terminal or Terminal Emulation	Allows terminal access to applications running on host systems, such as Mainframes, VMS, or UNIX. PC's doing terminal emulation can generally also do file transfer.
Client/Server Applications	Typical examples are Windows based applications which use a DBMS server such as Oracle, or Sybase. The application may be installed on the remote computer or on a remote access server.
LAN network server Applications	Allows the user to run applications which depend on access to a LAN network server. Typical examples are applications based on dBase, Paradox, or Btrieve databases.

Desktop Applications	Allows the remote user to run desktop applications not installed on the remote computer. Typically this is done to avoid the cost and complexity of installing applications on remote computers.

Remote Access Methods

Direct Terminal Connection

The remote user has a terminal, or a PC doing terminal emulation, and a modem. On site equipment to support basic terminal access is typically either a modem pool connected directly to a host system, or a modem pool connected to one or more terminal servers or front end processors.

Terminal access allows use of host based applications, host based e-mail, and file transfer. Terminal access has minimal requirements for hardware, technical support and administration.

Direct terminal connection is a mature technology approaching obsolescence. It is in wide use for mainframe and mini-computer applications. Though it is still useful and can be the most cost effective solution for specific applications, direct terminal connection does not address the new needs of LAN based, client/server, and PC desktop applications. Terminal access can also be provided via the Remote LAN Node and Remote Control approaches (see below).

Dial-Up E-Mail or Messaging Gateway

A dial-up e-mail gateway is the cheapest, and simplest way to provide remote access to e-mail. Remote users are limited to using features provided by the e-mail program. This provides excellent security, preventing access to LAN network servers and all types of applications and data except e-mail. All leading PC and Macintosh based e-mail packages offer some form of remote access gateway. Some messaging products provide a surprisingly wide range of functions via a dial-up gateway. For example, Lotus Notes can provide e-mail, file transfer, workflow, discussion groups, information sharing, and document management functions via direct dial-up access.

Dial-up messaging gateways are a mature, reliable technology. They are typically chosen in cases where remote access to an entire LAN is not desired, or as a low cost way to provide e-mail access to remote users who do not need other forms of access.

Remote LAN Node

This is essentially the same as connecting the remote computer to the local LAN, except that communication over a modem is at a much slower speed than a local ethernet or token ring connection. A remote node connection generally requires a more complex configuration on the remote computer than other access methods. All applications to be used must be installed on the remote computer, unlike the Remote Control approach, which allows remote users to run applications located on the on-site LAN. Vendors are

making progress toward simplifying remote node connections. Notable examples are Apple's Appletalk Remote Access, and Microsoft's RAS, which comes with Windows for Workgroups.

Remote node connections are not well suited for LAN network server based applications. Moderate to large LAN database applications often experience very poor performance over remote node connections because of the large amount of data transferred between the remote computer and the network server via modem. Client/Server database applications generally fare much better than LAN network server applications on remote node connections because there is typically far less data transferred between the database server and the remote computer. For example, a LAN based application might transfer an entire data file to allow the remote computer to display a few records. In the same situation, a database server would only send the few required records.

Because of their great flexibility, remote node connections can be a considerable security risk. Without proper configuration, products such as Microsoft Windows for Workgroups and Appletalk Remote Access can allow unrestricted access to desktop computers.

The on-site requirements for remote node access are minimal. A modem pool, and a remote access router are all that is required. Remote access routers are provided by specialized vendors such as Shiva and DCA, by network hub and router vendors such as 3Com and Digital Equipment, and by NOS vendors such as Novell and Microsoft.

While Remote LAN Node technology has long been available, it is only recently becoming practical for many organizations. Early remote node offerings were difficult to support and generated a lot of administrative work. Apple Computer led the way in offering simple remote node access with Appletalk Remote Access, which has become the de-facto remote access standard for Macintoshes. Remote node access is expected to become much more prevalent, primarily because it is now a standard feature of the Windows for Workgroups operating system, and is expected to be a standard feature of Windows 95 and other future Microsoft operating systems.

Remote Control

In this type of remote access, the remote computer runs a remote control program, such as PC Anywhere, Co-Session, or Reach Out, to control an on-site PC known as a remote access server. All application processing is done on the remote access server. Only keystrokes and screen display information are transferred via modem. Remote control allows all types of remote access functions. Since all application processing is done on the on-site remote access server, applications need not be installed on the remote computer.

Remote Control is currently the most commonly used approach for PC's accessing LAN's. Many organizations have chosen this approach because it allows central control and configuration of applications, and requires minimal technical support and software installation for remote users. Since Remote Control makes minimal demands on the remote computer, remote users generally require less expensive hardware. However,

Remote Control requires a dedicated PC for each concurrent remote user, or a specialized, multi-processor remote access server such as those offered by Citrix.

Remote Control provides excellent support for DOS based applications. The transition to Windows has been difficult for many organizations dependent on remote control, since most vendors were slow to offer remote control of Windows. Remote control of Windows is currently a viable option, and is considered the conservative choice in many organizations. Remote control for Macintoshes exists, for example Timbuktu, but is not the preferred choice because of the widespread availability of Appletalk remote access, which Apple has distributed with every PowerBook notebook computer.

In the long run, several trends threaten the dominance of remote control for PC's. Remote Node technology is maturing, and is now a standard part of the Microsoft Windows operating systems. The Client/Server approach to database applications is becoming prevalent, and does not require remote control for adequate performance. The widespread shift to Microsoft Windows has dramatically increased hardware requirements for remote access servers.

Public Access: The Internet

The Internet is a world wide network interconnecting loosely associated corporate, government, and educational networks. The Internet has been very much in the news recently, and is experiencing rapid growth. The Internet has long been used to provide remote terminal access, file transfer, and access to client/server applications by educational and government institutions, and high-tech businesses.

The Internet is probably not the most cost effective or secure way to provide remote access to remote users within the County, but it has a unique ability to provide controlled access to information, and exchange of e-mail for business partners, contractors, and the general public. As the cost of access has decreased, progressive local governments, such as the City of Palo Alto, have begun to provide public information and public forums for discussion on the Internet.

Internet access is a large subject, and a complete discussion is beyond the scope of this document.

Security

Because it opens the WAN to access via a public telephone or ISDN line, remote access poses a considerable security risk. This risk is one of the first and largest obstacles to providing remote access in many organizations, since addressing it requires a clear policy specifying who controls access to data and applications on the WAN, and cooperation between system administrators in various agencies in implementing security policies. The following table gives an overview of the security tools available.

System Component	Security Provided

Operating System	Network Operating Systems (NOS), Database Server Operating Systems, and Mainframe or Minicomputer operating systems provide username and password based security, but require specialized expertise to insure a secure configuration.
Router	Routers can be programmed to restrict the flow of various types of traffic between LAN's. This isolation technique can be used to limit the risk to the WAN posed by remote access to a particular LAN. Some degree of isolation is often required to reduce contention for WAN bandwidth anyway.
Dial-Up Server	Dial-Up servers can restrict access by requiring the user to wait for a call-back to a pre-defined number, or by requiring a separate level of username and password checking before allowing any connection to the LAN. Some dial-up servers can restrict access to a particular network segment, or a particular network server.
DBMS or Application Server	DBMSs and other application servers typically provide their own logon procedures, but can sometimes be integrated with the operating system or a security server.
Security Server or Switch	Specialized security switches or servers are available which employ advanced encryption techniques, id cards, or continually varying password devices. These systems are expensive, but are now relatively well integrated with Network Operating Systems.
E-Mail Gateway	E-Mail gateways typically use traditional username and password, or public key encryption, and generally pose little risk because they are restricted to use for e-mail.

Due to the specialized expertise required to analyze security issues, many organizations forgo remote access entirely, or provide only highly restricted access. There is now a wide range of security tools available, and with proper planning and organization, remote access can provide considerable benefits.

Physical Connection - A New Option

The standard physical connection method for remote access is a telephone line and a modem. This approach is still adequate for most remote access uses, and will be in use for many years to come due to the high cost of installing other options at both ends of the remote access connection.

An emerging technology with great potential is ISDN, (Integrated Services Digital Network), a new type of multi-purpose communication service offered by telephone companies. ISDN is not easy to obtain in all areas, but offers excellent speed (64Kbps or 128Kbps) at much lower cost than traditional leased lines. An added feature of ISDN, making it attractive for remote applications, is that smart ISDN interface controllers can automatically disconnect during idle times and reconnect as needed, reducing toll charges. ISDN is relatively expensive to install, and is still hard to get in some areas, but hardware prices are rapidly dropping, making ISDN a reasonable choice for some high use applications with high performance requirements. ISDN can also be used as a low cost LAN to LAN connection, and should be considered for this purpose during network planning.

Considerations for the Selection of Remote Access Products and Components

Given the state of the market and technologies for Remote Access, the following criteria should be considered when making product selections:

General Guidelines

- Consider the impact of any remote access system on the entire WAN. Unless a particular LAN is isolated from the WAN, a local decision to provide remote access potentially affects all County users.

- Some degree of central planning and control is required to maintain security and reliability of the WAN when remote access is allowed. Planning must be coordinated among network administrators, system administrators of host systems, and database server administrators across agencies.

- For a given application, choose a remote access method appropriate for the level of functionality and security required. E-Mail access will be adequate in many cases for information exchange with external organizations such as vendors, and consultants, and is a low cost, high security approach.

- To minimize administration costs, choose remote access products which allow security to be integrated with network operating system security, and those which support a shared security database for multiple servers.

- When connecting very small remote offices to the WAN, consider using remote access techniques instead of a full-time WAN connection. For some, remote offices e-mail alone may be adequate.

Application Specific Guidelines

- Tele-commuting support generally requires access to files and applications. Generally, Remote Node or Remote Control access will be required for tele-commuting.

- Remote control is generally the preferred remote access approach for LAN network server based databases.

- In PC applications where the workstation requires complex configuration, Remote Control is likely to minimize technical support and system administration costs.

- Client/Server databases reduce I/O requirements and therefore provide greater flexibility in remote access.

- Design client/server database applications to take advantage of server based security features such as views, stored procedures, and dynamic role based security. This allows flexible access to data with minimal risk.

- Document image processing and other client/server applications which involve viewing large bitmap images work best with Remote Node access, or a specialized application server such as Lotus Notes.

Access Method Specific Guidelines

- When choosing products to provide Remote Node access look for products which support multiple widely accepted network transport protocols. For example:

TCP/IP and IPX/SPX support should be minimum requirements. Support for a standard connection protocol, such as PPP (Point to Point Protocol) is another significant long term advantage.

- Based on market trends and low hardware requirements, Remote Node is likely to be the lowest cost remote access method for large numbers of general purpose tele-commuting users.

- Computers connecting as remote nodes should generally not be configured to run software stored on a network server across a modem link.

- E-mail, and file transfer functions are generally made available by Remote Control and Remote Node access, and do not necessarily require additional products. Terminal emulation can usually be made available in this way, with the purchase of separate software.

- Remote Control access can generally be provided on a remote node connection, but the reverse is not true.

Specific Guidelines

Given the stated technology considerations and the business directions of the various County agencies, the following guidelines for specific product selection should be considered:

- E-mail should be used for remote access, whenever possible, to avoid security issues.

- Other remote capabilities should be provided through more secure channels. Tiers of functionality would include: Dial-up Email, mobile access to email and files, and full remote access (including data access).

- The Internet should be evaluated as the solution for e-mail activity, as well as outbound access.

System Management

Description

System management software adds additional administrative capabilities to the underlying functionality of the components of the network. Typically, network operating systems already provide a basic level of functionality in these areas. These software packages integrate with network operating systems, application servers, desktop operating systems and other components of network to provide enhanced information gathering, reporting, control, and troubleshooting capabilities to the system administrator.

Issues

Guidelines for the selection of systems management products should address the following issues and criteria:

- Range of operating systems and hardware on the network.

- Current lack of distributed systems security.

- Guidelines for compliance and direction of current security policy.

- Minimize any additional resource requirements for workstations and servers being managed (memory and disk, for example).

- Availability of statistics reporting such as resource utilization.

State of the Market

There are currently two major classes of products in this category: those that have evolved out of the Internet standard Simple Network Management Protocol (SNMP) associated historically with the UNIX and TCP/IP world, and those that have evolved to address the needs of network managers using one of the popular Network Operating Systems.

Those packages based on SNMP tend to be relatively expensive and complex to set up, and·typically run on the one or more UNIX platforms. Two excellent examples of this type are Sun Net Manager from Sun Microsystems and OpenView from Hewlett Packard. These packages are an excellent choice for large and complex LAN/WAN environments. Using the SNMP protocol, the SNMP Manager software (typically running on a UNIX workstation) allows the administrator to view statistics and modify configuration information on a wide variety of devices attached to the network, including servers and workstations, routers, cabling hubs, and terminal servers. In order for the device to be manageable through SNMP the device must implement SNMP Agent software, typically available as a standard or optional feature on most operating systems and hardware devices.

The most sophisticated implementations allow the network administrator to create a graphical map of your network, set thresholds for various statistics and send alerts to the appropriate person when a problem on the network is detected. These products are strong on traffic monitoring, hardware inventory and remote configuration, but are relatively weak or provide no functionality at all in the areas of software distribution and metering, control of client environment, storage management and archiving and backup.

Historically, these products have utilized TCP/IP (SNMP itself uses TCP/IP as its transport), but in the past two years have begun to expand their scope to include other popular network protocols including IPX/SPX , Appletalk, and OSI.

Those packages evolving out of the Network Operating System market tend to be less expensive and easier to set up than their SNMP-based counterparts. The package's user interface typically runs on many of the most popular desktops including Windows 3.11, Macintosh, and OS/2. They typically take advantage of a software agent installed to run

on all of the client workstations on the LAN/WAN (for example a TSR might be started during logon from a DOS workstation), and a software component running on the network server.

This group of software products has matured considerably in the last few years to include a rich mix of capabilities. Important vendors in this arena are Novell, Microsoft, Symantec, Saber Software, McAfee Associates, and Frye Computer Systems. Many of the larger vendors offer a complete suite of software with some components focused on hardware and software inventory, other on virus detection, and another on control of the client environment.

Considerations for the Selection of System Management Products

Given the state of the market and technologies for Systems Management, the following features and functionality should be considered when selecting product(s) for systems management:

- Windows-based interface
- Workstation configuration features
- Hardware and software inventory control
- Flexible reporting
- Server monitoring
- Control of client environment
- Network traffic monitoring
- Support for multiple protocols
- Alerting and notification
- Software metering
- Software distribution
- Virus detection and removal
- Support for domains & groups (name services)
- Storage management
- Archiving and backup
- Network management of Hubs, routers or cards

Specific Guidelines

It is recognized that the System Management market is relatively immature and the County does not have substantial investment in this technology. General recommendations for agencies interested in System Management applications are:

- Managing Network Infrastructure (connectivity). A project is currently underway to implement a software package in this area. The products being implemented are Netview 6000, LatisNet for UNIX, and Optivity (help desk). Any technology considered should have strong support for TCP/IP.

- Application and Network Server Management. Packages should provide for distributed support. Additionally, support for TCP/IP and SNMP should be required. Should provide strong support for desktop and server guidelines. Examples would be Netware 3.12 & 4.x and Windows for Workgroups. Should provide strong support for the County's wide area network environment. This includes ability to support direct and dial-up network connections (including home or field access).

- Software Management. Software applications should be installed on the LAN (when appropriate) to facilitate license and version control.

- System Security. Packages should provide security of distributed systems. Look for packages which also allow the administrator to consolidate and central security profiles for applications and DBMSs on the network

- Desktop Configuration. Packages should provide administration and configuration of desktops (e.g., desktop OS versions, network software and protocols) on the network.

Workflow Management

Description

Workflow management software generally is applied to two situations: *rigid workflow,* such as in the approval process for a loan application, and *ad hoc workflow*, as in the processing of a customer service complaint. In the loan application case, large volumes of applications go through the same stages of review, with fixed logic for routing loans that are rejected, approved, or need additional work at any particular stage. In ad hoc workflow such as customer service, a customer complaint may need to be routed to various people in order to get resolution. The customer service representative decides upon a routing of the complaint based on the situation, and the workflow software will track its progress.

Rigid workflow is most often built upon database technology, while ad hoc workflow is often e-mail based. However, new messaging standards such as MAPI, together with intelligent SQL databases that can store 'workflow rules' and trigger e-mail messages after a database transaction occurs, are providing an open, extensible foundation for future workflow applications.

Issues

County guidelines for workflow management software should be conceived with the intention of:

- Accelerating agency workflow while providing flexibility to respond to changing requirements.

- Minimizing administration and technical support.

- Insuring interface compatibility with existing and future data systems, specifically the ability to trigger actions on these systems.

- Maintaining a unified messaging infrastructure supporting intra-agency and inter-agency communications.

State of the Market

Workflow implementation tools range from simple e-mail add-ins that add forms and forwarding rules to e-mail to proprietary vertical solutions optimized for such tasks as credit card application processing. Increasingly, corporations and government agencies are recognizing that re-engineering of their processes will require them to establish a common messaging and workflow architecture so as to ensure the intercommunications necessary to improve efficiency.

Recognizing this need, large-scale messaging providers such as Lotus and Microsoft are providing the infrastructure in terms of tool sets and APIs by which it is becoming easier to offer a "custom" workflow solution based upon a common framework. Similarly, commercial workflow solutions can be purchased which are built upon the two pillars of an open standard: MAPI 1.0, and SQL database storage.

Here are brief synopses of several workflow implementation tools currently on the market.

Ad hoc e-mail routing

An example of ad hoc e-mail routing is offered in products such as *Reach Software's Beyond Mail. Beyond* implements workflow routing through its own e-mail and forms client. Beyond Mail permits forms and workflow rules to be defined and stored as a part of the form itself. As the form is being processed, logic scripted into the form determines its next routing.

Routing with database queues

An example of routing with database queues is *Action Technologies Action Workflow. Action* allows the workflow designer to define process diagrams detailing workflow and logic, then is able to generate the SQL table structure necessary to implement the workflow. In the case of SQL databases, it is then up to the user to build forms, using a database front-end, that actually implement the application. Alternatively, if the underlying data is to be stored in Lotus Notes, Action will generate both the forms and the routing information to generate the finished Notes application.

Simple forms data entry and routing

Lotus Notes is one of the few products today which combines electronic forms capability with e-mail messaging in a client-server implementation. With Notes, one can easily design the forms for a workflow application, script the workflow in Notes scripting language, and then let Notes handle many of the administrative headaches such as access, replication, etc. Products such as Action extend notes to provide a graphical workflow designer.

However, Note's scripting language has limitations, and the product is best suited for applications where the object being worked upon is the "document of record". Workflow applications in which the object is both a "pointer to a document" such as a form and primary key for data stored in a SQL database, may well find the implementation of database routing to be simpler to implement.

Combining forms and database updates with routing

Workflow applications which combine forms with database updates and routing continue to dominate mission critical applications. In these cases, database front-ends such as PowerBuilder, SQL Windows, and Visual Basic which can easily access both database data and messaging APIs are often used to develop custom solutions. The key here is that these applications are now utilizing open and extensible technologies such as SQL databases and standard messaging, and not locking their logic or data in proprietary formats.

Today there are only two recommended solutions for the body of simple workflow implementations where e-mail is the active application by which a person will be notified of work:

- Visual Basic E-Forms and ODBC with ORACLE and SQL Server
- Lotus Notes with SQL extensions

Implementing the many small but essential enterprise applications such as expense reporting, vacation requests, and insurance billing on one of these two standard architectures greatly eases administrative burdens, and assures that only one set of software and forms need be made available to clients on the network.

Vertical market solutions

Vertical solutions should satisfy two criteria: That workflow data and information be accessible via open API standards such as SQL APIs and MAPI. With these criteria met, application solutions such as credit card processing or Accounts Payable provided by outside vendors can be safely integrated with existing and future needs. Vendors such as Dun and Bradstreet, SAP, and Unisys offer several solutions that meet these criteria.

Considerations for the Selection of Workflow Management Products & Components

Given the state of the market and technologies for Workflow Management, the following criteria should be considered when making product selections:

Choose the correct routing implementation: database, e-mail, or both.

Perhaps the most important decision in choosing a workflow architecture is to decide whether the application(s) calls for routing based on e-mail messaging, database queue tables, or a combination of both.

E-mail routing is best suited to ad hoc routing situations, where the document or object itself is to be sent to individuals on the route, and little administration or tracking is necessary. To be successful, e-mail routing requires that the document being passed be the "document of record". Any changes made to it along the way are passed along with the document to the next routing stage. No more than one person is working on the data at any one time, and the document is always current.

Database routing is best suited for situations involving rigid workflow, where a document or form passes through stages of review, and the actors on the object have generic roles rather than are specific individuals. This situation often involves high volume processing, and queues are maintained at each level from which multiple people authorized to handle the document at that level draw the next document to work on. Moving a document to the next stage may mean as little as setting its "status" to the next level.

Database routing has advantages in that the queues may be dynamically managed and monitored. Furthermore, routing rules can be set up and maintained centrally within the database to route transactions and documents according to the business rules of the process. Higher levels of integrity and security may be achieved because these are naturally supported by the database. If there is a disadvantage to database routing, it is that it lacks a means of actively notifying the next agent that there is work to be done. Everyone involved in the process must usually be running the workflow application itself, allowing it to passively scan the queues for something to do.

A combination of database routing with e-mail messaging for notification is the most flexible routing implementation. This method allows routing rules to be maintained as triggers and procedures within an intelligent SQL database. It also uses messaging standards such as MAPI 1.0 to provide for active notification. With MAPI 1.0 and a forms-aware e-mail client, notification can take from within standard e-mail packages.

Decide whether to pass the object (document) or a pointer to the object (document).

An example of the former is a word-processing document. The latter might be the name of the form to display and the key of the record identifying the data to retrieve. Most mission critical workflow applications are of the latter type, and lend themselves to either database routing or a combination of database queues with messaging notification.

Choose a forms tool that can be invoked from within your standard e-mail package, and which possesses interfaces to standard SQL databases through ODBC or an ODBC OLE object.

- Look for a language that people may already know, such as Visual Basic.
- External hooks to retrieve DBMS data: ODBC; ODBC object.

- Forms that can be retrieved by the base e-mail software already in place: E-Forms or Notes.

Be sure forms will be accessible by those who will need them on your network.

Many third party packages require the workstation to have access to a forms files residing on a network server, creating an administrative and logistical challenge depending upon the size of the enterprise. Large networks with multiple network servers will need to replicate these forms to multiple servers so as to make them accessible. More sophisticated packages, such as Lotus Notes, will performs this replication automatically.

To be sure your workflow application will interface with existing applications, and with future such applications, workflow applications should:

- Route messages and notifications upon a consistent e-mail standard: MAPI 1.0.

- Build database retrievals upon an open, extensible DBMS standard: SQL standards such as ODBC or ODBC object.

To ease administration and system management:

- Workflow administration tools should support queue management and show work in progress.

Specific Guidelines

It was identified that the workflow market is relatively immature and the County does not have substantial investment in workflow technology. General recommendations for agencies interested in workflow applications were:

- Look at available workflow products and compare capabilities to requirements.

- Agencies should apply the guidelines for other technology areas when making purchasing decisions. Proprietary components should be avoided (database component, for example).

- Re-engineering should preface workflow implementation. This will avoid automation of poor workflow practices.

- A workflow pilot should be identified and initiated.

GLOSSARY OF ACRONYMS

GLOSSARY

API   Application Programming Interface. Language and message format used within a program to activate functions that are either part of that development system or are external within another module, program or system.

BLOB   Binary Large Objects. A database field that holds any digitized information.

CASE   Computer Aided Software Engineering. Software tools which provide automated methods for designing and documenting traditional structured programming techniques.

CD ROM   Compact Disc Read Only Memory.

CISC   Complex Instruction Set Computing. Traditional computer architecture that uses microcode to execute comprehensive instructions.

CMC   Common Messaging Calls. Programming interface specified by the XAPIA as a standard messaging API for X.400 and other messaging systems.

CPU   Central Processing Unit. Computing part of the computer.

CSM   County of San Mateo.

DBA   Database Administrator.

DCA   Document Content Architecture. IBM file formats for text documents.

EIS   Executive Information System. Information system that consolidates and summarizes ongoing transaction data for the organization.

EISA   Extended Industry Standard Architecture. PC bus standard that extends the AT bus (ISA bus) to 32 bits and provides bus mastering.

GUI   Graphical User Interface.

HSM   Hierarchical Storage Management. Moving data to slower storage media when the data is no longer needed for daily use.

ISA   Industry Standard Architecture. Expansion bus commonly used in PCs. It accepts the plug-in boards that control the video display, disks and other

peripherals.

ISDN   Integrated Services Digital Network. International telecommunications standard for transmitting voice, video and data over a digital line.

LAN   Local Area Network. Communications network that serves users within a confined geographical area.

MAPI   Messaging Application Programming Interface. Programming interface that enables an application to send and receive mail over the Microsoft Mail messaging system.

MHS   Message Handling Service. Messaging system from Novell that supports multiple operating systems and other messaging protocols.

MCA   Microchannel Architecture. An IBM 32-bit bus.

NFS   Network File System. Distributed file system that allows data to be shared across a network regardless of machine, operating system, network architecture or protocol.

NLM   NetWare Loadable Modules. Software that enhances or provides additional functions in a NetWare 3.x server. For example, support for database engines, workstations, network protocols, fax and print servers.

NOS   Network Operating System.

NTS   Microsoft NT Server.

OCR   Optical Character Recognition. Machine recognition of printed characters.

ODBC   Open Database Connectivity API. Programming interface from Microsoft that provides a common language for Windows applications to access databases on a network.

OLE   Object Linking and Embedding. Windows compound document protocol that allows one document to be embedded within or linked to another.

OODBMS   Object Oriented Database Management System.

OOP   Object Oriented Programming.

OS   Operating System.

OSI   Open Systems Interconnection. ISO standard for worldwide

communications that defines a framework for implementing protocols in seven layers.

PC   Personal Computer.

PCI   Peripheral Component Interconnect. Local bus for PCs from Intel that provides a high-speed data path between the CPU and peripherals.

PPP   Point to Point Protocol. Serial communications protocol for WANs defined by the Internet Engineering Task Force.

RAM   Random Access Memory.

RDBMS   Relational Database Management System.

RISC   Reduced Instruction Set Computing. Computer architecture that reduces chip complexity by using simpler instructions.

SMP   Symmetric MultiProcessing. Multiprocessing design in which any CPU can be assigned any application task.

SMTP   Simple Mail Transfer Protocol. Messaging protocol used in TCP/IP networks.

SNMP   Simple Network Management Protocol. Widely-used network monitoring and control protocol.

SQL   Structured Query Language. Language used to interrogate and process data in a relational database.

UNC   Universal Naming Convention. Standard for identifying servers, printers and other resources in a network.

VBX   Microsoft Visual Basic dynamic link library file that contains user-developed controls for Visual Basic applications.

VIM   Vendor Independent Messaging. Programming interface developed by Lotus, Novell, IBM, Apple, Borland, MCI, WordPerfect and Oracle. Programmers write to the VIM interface to enable an application to send and receive mail over a VIM- compliant messaging system.

VLB   Video Electronics Standards Association (VESA) Local Bus.

WAN   Wide Area Network. Communications network that covers wide geographic areas, such as states and countries.

XAPIA X.400 API Association. Consortium dedicated to standardizing X.400 and other specifications, such as the CMC messaging API.

XA X/Open Standard Architecture. An API developed by X/Open for application and database connectivity which includes support for distributed and heterogeneous environments.